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THE HISTORY OF EVOLUTIONARY THOUGHT[1]

AS RECORDED IN MEETINGS OF THE BRITISH ASSOCIATION

Professor Sir EDWARD B. POULTON, D.Sc., LL.D., F.R.S.

HOPE PROFESSOR OF ZOOLOGY AT THE UNIVERSITY OF OXFORD

SIR WILLIAM THOMSON, in his address at Edinburgh in 1871, said that "the real origin of the British Association" was given in the words of a letter written by David Brewster to John Phillips on February 23, 1831, a few months before the first meeting: "The principal object of the Society would be to make the cultivators of science acquainted with each other, to stimulate one another to new exertions, and to bring the objects of science more before the public eye, and to take measures for advancing its interests and accelerating its progress." That the time was fully ripe for the birth of the association is made very clear by the words written by John Keble to a friend, referring to the D.C.L. degrees conferred, at the Oxford meeting in 1832, on David Brewster, Robert Brown, John Dalton and Michael Faraday: "The Oxford Doctors have truckled sadly to the spirit of the times in receiving the hodge-podge of philosophers as they did"—an opinion on which Lord Salisbury commented at the Oxford meeting in 1894: "It is amusing at this distance of time, to note the names of the hodge-podge of philosophers whose academical distinctions so sorely vexed Mr. Keble's gentle spirit." It is not only amusing but pathetic that such words should have been used by a revered member of a university which had done splendid service for science, as has been so well shown in Dr. R. T. Gunther's volumes.[2]

Faced by the serious duty of preparing this address, I felt that the best hope of interesting you would be to choose a subject which has received special attention at our meetings. I have selected the progress of thought on organic evolution as it may be followed in addresses,

[1] Address of the president of the British Association for the Advancement of Science, given at Nottingham, September 1, 1937.

[2] "Early Science in Oxford," vols. i–xi.

papers and discussions, mainly restricting myself to the series of meetings which began with the jubilee at York in 1881, the first of many that I have had the pleasure of attending.

The British Association provides a very favorable field for the discussion of many-sided subjects such as evolution—subjects which attract members from very different as well as from closely related sections. Hence a wide range of varied experience is open to one who can look back over more than half a century; and I do not propose to exclude some of the humorous sayings and incidents which, from time to time, have enlivened our meetings and contributed to their success. Some of them certainly deserve to be rescued from oblivion, although to perform this pious duty I must risk the enmity of the Goddess of Folly, who, as Erasmus tells us, proclaimed: "I hate a man who remembers what he hears."

The fiftieth anniversary at York was a memorable meeting, with Sir John Lubbock (Lord Avebury) as president, and the chair of every section except economics, under Grant Duff, taken by a past-president of the association.

I then enjoyed to the full one of the chief benefits conferred by our association upon its younger members —the opportunity of meeting older men, up to that time only known to them by the fame of their discoveries. Professor O. C. Marsh had come over from Yale, his main object being to buy for his university museum the second and more perfect fossil of the wonderful ancestral bird Archeopteryx with teeth and a long, lizard-like tail—clear evidence of reptilian origin. The earlier example had been bought for the British Museum at a price which was said to have provided the dowry for a professor's daughter, and Marsh soon realized, as he told me, that the second was not for sale on any terms. "We let the other go and I believe they would kill me if this were sold" was the reply given to him by the authority in Munich. He was, however, able to study the fossil, and his description and drawings of the teeth, in the Geological Section, followed the only attack on evolution itself, as distinct from its causes, which I have ever witnessed at any of our meetings. It was the exhibition by H. G. Seeley of his reconstruction of Archeopteryx from this fossil, which aroused the fury of the paleontologist, old Dr. Thomas Wright of Cheltenham: "Archeopteryx hasn't got a head, how can it possibly have teeth?" he growled, knowing nothing of the latest find or of the fact that a detached head and scattered teeth had been detected on the slab in which the older specimen was embedded. In spite of Professor Newton's positive statement and the form of the teeth, drawn by Professor Marsh at the request of the chairman, Dr. Wright, quite unconvinced, continued muttering "Archeopteryx is a very good bird," its virtue in his opinion entirely uncontaminated by any taint of reptilian affinity.

Professor Marsh also read a paper in the Zoological Section on his own wonderful discoveries of toothed birds from the rocks of the western United States. Richard Owen, president of the section, was in the chair and, with the memory of old and embittered controversies in his mind, the author told me that he had felt rather anxious in bringing this communication forward. But in that friendly atmosphere there was no reason for alarm. Owen welcomed the paper warmly and in confirmation told us, in the most charming manner, of the traces of teeth found in an embryo parrot.

The event which stands out most clearly in my memories of the jubilee meeting is Huxley's evening lecture on "The Rise and Progress of Paleontology"—the science which provides an essential part of the foundation on which geographical, geological and biological evolutionary history has been built. The insuperable difficulty felt by the older naturalists was to believe that the land had been for the most part deposited under the sea, and to account for the presence of fossils, or as they were called, "formed stones." The true solution, Huxley explained, was found and published in 1669 by Nicholas Steno, a Danish professor of anatomy at Florence, who carefully studied certain fossils, known as "glossopetre," which abounded in the Tuscan rocks and were believed to be fossil fig-leaves. Steno, who was not satisfied with this interpretation, dissected a shark's head and showed that the "glossopetre" exactly correspond in every particular with the teeth—"that in fact they were shark's teeth." The emphasis with which Huxley made this statement comes back to me after the lapse of nearly sixty years. From this Steno was led to conclude that they were the teeth of shark-like fishes living in the Tuscan sea and later embedded, with other remains, in the strata which had there accumulated.

I have not noticed the fanciful suggestion of "fossil fig-leaves" in any published version or account of Huxley's lecture that I have seen, but he certainly told us of it and it is an interesting example of the attempts made by the naturalists of the day to explain the fossils embedded in rocks then believed to be of terrestrial origin. I can not resist the temptation of quoting Plot's[3] more ingenious and amusing effort to account for the well-known layer of oyster-shells (*Ostrea bellovacina*) found ". . . at some places here in *England*, particularly at *Cats-grove* [now Katesgrove] near Reading . . .; which how they should come here with-

[3] "The Natural History of Oxfordshire, being an Essay toward the Natural History of England," by Robert Plot, D.D. Printed at the Theater in Oxford. 1677. Dedicated To the most Sacred Majesty of Charles the Second, King of Great Britain, France and Ireland, Defender of the Faith, etc. (pp. 118–122).

out a *Deluge,* seems a difficulty to most men not easily avoided."

Plot was, however, helped "to a *salvo*" for his own objection by remembering that Reading was

> a *Town* of very great *action* during the *Invasions* of the *Danes,* who cutting a deep trench cross between the *Kennet* and *Thames,* and inclosing themselves as it were in an *Island,* held it against King *Ethelred,* and *Alfred* his Brother a considerable time; from whence in all probability, the *Saxons* having removed their *Cattle* and other provisions before the *Danes* arrival, 'tis likely that they might be supplyed from their *Navy* with *Oysters,* which during the time of the aboad of the *Army* on Land, might be a very suitable employment for it: Which conjecture, if allowed, there is nothing more required to make out the possibility of the bed of *Oysters* coming thither without a *Deluge,* but that *Cats-grove* was the place appointed for the *Armies* repast.

The probability of this suggestion may be inferred from the age of the "Woolwich and Reading" beds in which the oysters are found—estimated by my friends Professor Watts and Professor Hawkins at about fifty to sixty million years.

Dr. Plot's explanation of fossils in general as well as of flowers was of a very different kind. To account for their existence he appealed to "the wisdom and goodness of the *Supreme Nature,* by the *School-men* called *Naturans,* that governs and directs the *Natura naturata* here below, to beautifie the World with these varieties; which I take to be the end of such productions as well as of most *Flowers,* such as *Tulips, Anemones,* &c. of which we know as little use as of formed stones."

The modest and withal amusing paragraph which follows I venture to quote in full as an example to be followed in scientific controversy:

> And thus I have given the grounds of my present *opinion,* which has not been taken up out of *humor* or *contradiction,* with intent only to affront other worthy Authors modest conjectures, but rather friendly to *excite them,* or any *others,* to endeavor collections of *shell-fish,* and parts of other *Animals,* that may answer such *formed stones* as are here already, or may hereafter be produced: Which when ever I find done, and the reasons alleged *solidly* answered, I shall be ready with acknowledgment to retract my *opinion,* which I am not so in love with, but for the sake of *Truth* I can chearfully cast off without the least reluctancy.

One chief object which, as I believe, Huxley had before him was to bring forward a calm, clear statement of the evidence on which alone it was possible to achieve that "reconstruction of an extinct animal from a tooth or bone," which had made so deep an impression on the imagination. The reconstruction was in fact a simple inference based on anatomical experience such as that gained by Steno when he dissected the shark and concluded that the "glossopetrae" were the teeth of shark-like fishes. But this reasoning—that a fossil tooth or bone on the surface of a rock can not by itself enable the geologist to predict that a skeleton of a certain type lies hidden beneath—seeming to diminish the glory of Cuvier's splendid work, was resented by Owen, who had replied with the bitter taunt that a tooth can tell us a great deal—a donkey can kick his master but he can not eat him. This may have been the encounter referred to by Huxley when he wrote of a friendly meeting with Owen at the Zoological Section of the association in Leeds (1858): "so that the people who had come in hopes of a row were (as I intended they should be) disappointed."[4] In the same spirit, I think, Huxley was glad to speak of the "glossopetrae" at the jubilee meeting, where Owen was president of a section, and calmly and simply, to reaffirm conclusions which are unassailable.

Huxley then passed on to Steno's further study of fossils and his proof of their relationship to terrestrial freshwater and marine organisms, and to his application of this evidence to the past condition of Tuscany—all discussed "in a manner worthy of a modern geologist" and later extended by Buffon to all parts of the world then known to be fossiliferous. These conclusions, "which almost constitute the framework of paleontology," only required one addition, made towards the end of the eighteenth century by William Smith, who showed that geological strata contained characteristic fossils so that rocks of the same age could be identified in all parts of the world, while the biologist could follow the changes in the living population of the globe—a record of constant extinction and continual generation of new species. We were then led to three general conclusions: (1) the vast length of time during which life has existed on the earth—"certainly for millions of years"; (2) the continual changes which living forms have undergone during this period; (3) the successive changes in the best-known fossil groups are such as we should expect if each series "had been produced by the gradual modification of the earliest form. . . ." This last conclusion meant evolution which so completely accorded with recent discoveries that "if it had not existed, the paleontologist would have had to invent it."

I can never forget the words spoken to me after the lecture by a dear friend of my youth, the late Viriamu Jones, principal of University College, Cardiff: "At every sentence I felt myself bowing to Huxley and saying 'you are the greatest man here; no one else could have said that as you have said it.'"

As Huxley's lecture continued in a calm spirit an embittered controversy, so his thoughts on the immen-

[4] "Life and Letters," vol. i, p. 157.

sity of past geological and biological time lead naturally to another controversy on the age of the earth conducted intermittently at our meetings between 1892 and 1921. It is, I think, a good example of the invaluable help which the British Association brings to discussion when there appears to be a difficulty in reconciling the conclusions reached by the followers of different sciences. Lord Kelvin's estimate of a hundred million years as the period during which the earth had been cool enough to permit the existence of life upon its surface—a period reduced by Professor Tait to ten million—was a great difficulty to geologists and biologists who believed that an immensely longer time was required for the history of the fossiliferous rocks and the evolution of animals and plants. Thus, to quote only one instance, Darwin, writing to Wallace in 1871 and referring to "missing links," said, "I should rely much on pre-Silurian time; but then comes Sir William Thomson, like an odious spectre." The geologists resisted more firmly. Thus Sir Archibald Geikie, in his presidential address at Edinburgh in 1892, concluded his discussion of the subject with these words: "The geological record furnishes a mass of evidence which no arguments drawn from other departments of nature can explain away, and which, it seems to me, can not be satisfactorily interpreted save with an allowance of time much beyond the narrow limits which recent physical speculation would concede." At the Leeds meeting in 1890 I had many opportunities of meeting Professor John Perry, and when we were walking together on the Sunday afternoon I asked him to tell me something of the Kelvin-Tait conclusions and how far they must be accepted. He had been a demonstrator under Kelvin and spoke of the intense interest with which he had followed his lectures at Glasgow, and he gave me no hope of escape. His change of opinion, throwing a most interesting light upon the influence of the British Association, was the result of the presidential address at Oxford in 1894, when Lord Salisbury chaffed the believers in natural selection, telling them that he did not wonder that they required many hundred million years for so slow a process, but that "if the mathematicians are right, the biologists can not have what they demand. . . . The jelly-fish would have been dissipated in steam long before he had had a chance of displaying the advantageous variation which was to make him the ancestor of the human race." When Perry read this pronouncement, sweeping aside the firm convictions of biologists and geologists, he was led to reexamine the evidence and soon found a flaw. The heat of the earth had been calculated on the assumption of a conductivity uniform through the whole mass, but Perry showed that with a conductivity becoming higher with increasing depth the Kelvin-Tait estimate of the time required for cooling to the existing temperature—on which the age of the habitable earth had been based—must be immensely lengthened. Perry told me of this destructive criticism and very kindly helped me to make use of it in the address to Section D at Liverpool in which I replied to Lord Salisbury's amusing attack on the evolutionists.

Lord Lister was our president at Liverpool in 1896, and I can not resist the temptation to digress for a moment and recall the address in which one of the greatest benefactors of mankind told us, with the utmost simplicity and modesty, the story of his life's work and the success which, in spite of all opposition, had been achieved. To hear him was an enduring inspiration.

The year 1896 was also the jubilee of Lord Kelvin's wonderful half-century of achievement in research and teaching, and I could not help feeling some regret that any criticism of his work should appear at this particular time. But in the kindly spirit of our association such doubts were quite unnecessary. I well remember how he came one day to our sectional committee-room to bring me some volumes of his works, and how, as I have recorded before, in the following year as we were traveling across Canada after the Toronto meeting and the chance of collecting insects for a few minutes at each station could not be resisted, Lord Kelvin said to his wife, "My dear, I think we must forgive Poulton for thinking that the earth is so very old when he works so hard in one day out of all the endless millions of years in which he believes!"[5]

The one line of evidence which left some anxiety in 1896 was suggested by Helmholtz, who allowed the sun only eighteen million years to have been giving out radiant heat at the present rate—a period Lord Kelvin was willing to extend to 500 million—and this estimated maximum was also accepted by Sir George Darwin, who, in his address[6] at Cape Town in 1905, spoke of the new evidence obtained by M. and Mme. Curie in their proof that radium gives out heat, and quoting in confirmation the work of R. J. Strutt, W. E. Wilson and G. H. Darwin, finally concluded that "the physical argument is not susceptible of a greater degree of certainty than that of the geologists, and the scale of geological time remains in great measure unknown." The light thrown by radium upon the Helmholtz estimate was also referred to in the presidential address of Ray Lankester at York in 1906, of J. J. Thomson, quoting the work of Strutt, Joly and Rutherford, at Winnipeg in 1909, and became a predominant subject in the joint discussion on the age of the earth, between Sections A, C, D and K, at Edinburgh in 1921.[7] Lord Rayleigh in opening this discussion concluded "that

[5] Report, British Association, Centenary Meeting, p. 78, 1931.
[6] Report, British Association, pp. 514–518, 1905.
[7] Report, British Association, pp. 413–415, 1921.

radioactive methods of estimation indicate a moderate multiple of 1,000 million years as the possible and probable duration of the earth's crust as suitable for the habitation of living beings. . . ."

Even in the present year Sir Ambrose Fleming, in his address to the Victoria Institute, is reported in *The Times* of January 12 to have maintained that "We were not in possession of any generally agreed scientific modes of geological time measurement, but only with estimates which were based for the most part on personal predilection or guesses at truth." It is to be regretted that the conclusions of scientific colleagues should be attributed to "personal predilection," and as for "guesses at truth"—what are these but hypotheses; and surely the discoverer whose imaginative effort led to the thermionic valve and did so much to endow the world with the infinite possibilities of wireless—surely he has little cause to choose for the serious efforts of others the word which in this connection carries a suggestion of shallow irresponsibility.

Geologists and biologists do not profess to know the age of the earth as the abode of life, but they are sure that, in the words used by Sir William Turner at Bradford in 1900, its birth "must have been in the far-distant past, at a period so remote from the present that the mind fails to grasp the duration of the interval."

I fear that too much of our time has been occupied by the attempt to show that the field is clear for the discussion of organic evolution, but until this could be done any such discussion appeared to be well-nigh useless.

It is, I think, a mistake to emphasize too strongly the very natural shock received by many who read the "Origin" or heard of its teachings for the first time and without any preparation; and I believe an even greater mistake to criticize the clergy for the time that elapsed before their acceptance of the new teaching. I shall never forget the reception of Aubrey Moore's paper, "Recent Advances in Natural Science in their Relation to the Christian Faith," by the Church Congress at Reading in 1883.[8] No speaker could have carried his audience with him more thoroughly: there was not a single protest or indication of dissent—nothing but enthusiastic applause. The Bishop of Oxford, Dr. Mackarness, was in the chair when the paper received this unanimous welcome—only twenty-three years after the Oxford meeting at which another Bishop of Oxford put his rude and foolish question to Huxley. It is pleasant to know that their celebrated encounter left no bitterness, for Huxley wrote in 1891 to Francis Darwin—"In justice to the Bishop, I am bound to say that he bore no malice, but was always courtesy itself when we occasionally met in after years."

I remember as a youth receiving a gentle parental warning against committing myself too entirely to a belief in evolution—a very different experience from that of our president at Hull in 1922, my friend Sir Charles Sherrington, who in 1873 was persuaded by his mother to take the "Origin" with him on his summer holiday, with the inspiring words—"It sets the door of the Universe ajar!"

I have already recalled Dr. Wright's indignation at York in 1881 as my only experience of opposition to a belief in organic evolution at any of our meetings, and the published Proceedings confirm this impression of unanimity. Thus, R. H. Traquair, addressing the biologists at Bradford in 1900, said, "I hardly think that we should now find a single scientific worker who continues to hold on to the old special creation idea"; and Lord Salisbury at Oxford in 1894, referring to Darwin, said, "He has, as a matter of fact, disposed of the doctrine of the immutability of species. It has been mainly associated in recent days with the honored name of Agassiz, but with him has disappeared the last defender of it who could claim the attention of the world." The mention of this great American naturalist recalls Tyndall's fine address at Belfast in 1874 and his memories of Agassiz's words, "I was not prepared to see this theory received as it has been by the best intellects of our time. Its success is greater than I could have thought possible."

Huxley, who had seconded the vote of thanks to Lord Salisbury, wrote to Hooker a few days later: "It was very queer to sit there and hear the doctrines you and I were damned for advocating thirty-four years ago at Oxford, enunciated as matters of course—disputed by no reasonable man!—in the Sheldonian Theater by the Chancellor. . . ."[9]

A letter written two days earlier to Boyd Dawkins records Huxley's opinion of another part of the address. "Lord Salisbury gave himself away wonderfully, but he was so good about Darwin himself that I shut my eyes to all the nonsense he talked about Natural Selection.[10]

Leaving now the subject of organic evolution itself, as generally accepted, I wish to speak on the difficult question of its motive causes, which for many years have formed the subject of addresses, discussions and papers at our meetings. The great division into two opposed theories of causation became clear in 1887 when Weismann attended the meeting at Manchester, and a discussion on "The Hereditary Transmission of Acquired Characters" was held in Section D. From

[8] "Science and the Faith," London, pp. 222–235, 1889.

[9] "Life and Letters," vol. ii, p. 379, 1900.

[10] From a letter of August 10, 1894, printed in the *Jesus College (Oxford) Magazine*, for Lent Term, 1928; and reprinted in *Hope Reports*, xvi: no. 3, p. 6, 1929. (Privately circulated to many scientific libraries.) Huxley's letter of August 18, 1894, to Lewis Campbell ("Life and Letters," vol. ii, p. 379) refers to the same subject.

that time evolutionists attending our meetings have been either "Lamarckians," following Erasmus Darwin, Lamarck, Buffon and Herbert Spencer, or "Darwinians" who followed Darwin and Wallace. Darwin himself, however, included the Lamarckian conception of "use-inheritance" as a motive cause, although believing it to be far less important than natural selection. The term "Neo-Darwinian" has therefore been applied to those who, accepting Weismann's teaching, reject "use-inheritance" altogether.

It must always be remembered that, apart from any theory of causes, the world owes its belief in organic evolution to all the great men whose researches and teaching have founded the two schools, and perhaps chiefly, at any rate among the English-speaking nations, to Herbert Spencer. I was first led to realize the extent of his transatlantic popularity when I learned from an American story greatly enjoyed in those far-off undergraduate days that his books were keenly appreciated by a bashful hero, who was so far from sharing the sublime confidence of their author, that he was only led to perform the most fateful action in life by the pressing advice of a very young nephew who assured him, in the presence of the lady, that if he was fond of her, the proper thing to do was to kiss her. Herbert Spencer's infallibility certainly lent itself to such stories as that of his supposed reply to an argument—"That can't be true, for otherwise "First Principles" would have to be re-written—and the edition is stereotyped"; or how Darwin said that to read Spencer always made him feel like a worm, but that he retained the worm's privilege of wriggling, and at another time "wonderfully clever, and I dare say mostly true." But, allowing for a style which provoked these and other amusing comments, we must never forget that believers in the doctrine of organic evolution owe an immeasureable debt to Herbert Spencer.

James Russell Lowell's amusing lines in the "Bigelow Papers"[11] appear to prove that Lamarckism was prevalent in America many years before the "Origin":

> Some flossifers think thet a fakkilty's granted
> The minnit its proved to be thoroughly wanted,
> . . . . . .
> Ez, fer instance, thet rubber-trees fust begun bearin'
> When p'litikkle conshunces come into wearin',—
> Thet the fears of a monkey, whose holt chanced to fail,
> Drawed the vertibry out to a prehensile tail.

The year of the Manchester meeting, 1887, was the fiftieth anniversary, and we are now celebrating the centenary, of the entry in Darwin's pocket-book: "In July opened first note-book on Transmutation of Species. Had been greatly struck from about the month of previous March on character of South American fossils, and species on Galapagos Archipelago. These facts (especially latter), origin of all my views."

It is especially interesting to recall that these views, as Professor Newton told us in his address to D, the Biological Section, did not include natural selection, which only came into Darwin's mind when he read Malthus, "On Population," in October, 1838. Newton, who had read the proof-sheets of the great "Life of Darwin," published later in 1887, then spoke of Wallace's independent discovery, made twenty years after Darwin's, a discovery suggested to him also by reflecting on Malthus, and of the friendship between the two great men to whom this fruitful conception had come, referring the cynic who would "point the finger of scorn at the petty quarrels in which naturalists unfortunately at times engage" to this "greatest of all cases, where scientific rivalry not only did not interfere with, but even strengthened, the good-feeling which existed between two of the most original investigators." And here I can not resist the desire to quote a part of the speech made by Wallace at the most thrilling scientific gathering I have ever attended—the fiftieth anniversary of the Darwin-Wallace Essay read before the Linnean Society on July 1, 1858, only twelve days after the arrival of Wallace's letter and manuscript from the Moluccas. Wallace then said, on July 1, 1908:

> The idea came to me, as it had come to Darwin, in a sudden flash of insight: it was thought out in a few hours . . . and sent off to Darwin—all within one week. *I* was then (as often since) the "young man in a hurry": *he*, the painstaking and patient student, seeking ever the full demonstration of the truth that he had discovered, rather than to achieve immediate personal fame. . . . If the persuasion of his friends had prevailed with him, and he had published his theory, after ten years'—fifteen years'—or even eighteen years' elaboration of it—*I* should have had no part in it whatever, and *he* would have been at once recognised, and should be ever recognised, as the sole and undisputed discoverer and patient investigator of the great law of "Natural Selection," in all its far-reaching consequences.[12]

Amusing evidence of the difficulty with which this "great law" was understood is afforded by a verse written by Lord Neaves and dated May, 1861:

> A deer with a neck that was longer by half,
> Than the rest of its family (try not to laugh),
> By stretching and stretching, became a Giraffe,
> Which nobody can deny.[13]

Yet Wallace, referring to Lamarck's hypothesis and "that now advanced," had written in his section of the joint essay:

[11] The lines are quoted from the First Part, published 1846–48.

[12] "Darwin-Wallace Celebration of the Linnean Society of London, pp. 6, 7, 1908.

[13] "The Origin of Species. A new song." In "Songs and verses, social and scientific," by an old contributor to *Maga*. Edinburgh, 2 Ed., 1868.

Neither did the giraffe acquire its long neck by desiring to reach the foliage of the more lofty shrubs, and constantly stretching its neck for the purpose, but because any varieties which occurred among its antitypes with a longer neck than usual *at once secured a fresh range of pasture over the same ground as their shorter-necked companions, and on the first scarcity of food were thereby enabled to outlive them.*

There were fortunately others who did not launch such ill-aimed criticism. Thus Professor Newton, reminding the section that the new teachings had been at once accepted by Canon Tristram[14] before the appearance of the "Origin of Species" (on November 24, 1859), expressed, with all the enthusiasm of one who was devoted to the same delightful branch of natural history, "the hope that the study of ornithology may be said to have been lifted above its fellows." It was indeed very fortunate that the Darwin-Wallace Essay should have been read so soon after its appearance by a naturalist who looked on the species question as did Tristram—a great traveler and observer who studied indefatigably the birds he loved, as living creatures and in as many countries as he could visit.

At the last meeting of the British Association in Nottingham (1893) Canon Tristram was president of Section D and, in his address, gave an account of the observations referred to by Newton at Manchester. The historic interest of this early acceptance of natural selection is such that I have prepared a brief abstract of his chief conclusions.

During a visit of many months to the Algerian Sahara in 1857–58, he "noticed the remarkable variations in different groups, according to elevation from the sea, and the difference of soil and vegetation." On his return he read the Darwin-Wallace Essay and wrote, "It is hardly possible, I should think, to illustrate this theory better than by the larks and chats of North Africa." He then explained how the colors arose by selective destruction of birds which harmonized less well than others with the surface of the desert. And similarly with other larks having "differences, not only of colour, but of structure," chiefly "marked in the form of the bill." He took as instances a very long-billed lark (*Galerita arenicola*), resorting exclusively to the deep, loose, sandy tracts, and a very short-billed allied species (*G. isabellina*), haunting the hard and rocky districts. He then pointed out that there is individual variation in the bills of larks and that the shorter-billed birds would be at a disadvantage in obtaining food from sandy areas but at an advantage among the rocks where strength is required. He concluded, "Here are only two causes enumerated which might serve to create, as it were, a new species from an old one. Yet they are perfectly natural causes, and such as I think must have occurred, and are possibly occurring still. We know so very little of the causes which in the majority of cases, makes species rare or common that there may be hundreds of others at work, some even more powerful than these, which go to perpetuate and eliminate certain forms "according to natural means of selection.'"

The temptation to record an amusing incident which happened at one of the meetings of Section D at Manchester can not be resisted. Work was proceeding smoothly under the genial guidance of Professor Newton when, suddenly, Dr. Samuel Haughton, of Dublin, entered and from the back of the room announced in arresting tones that he had an important communication to make about the animals preserved from the flood. He believed that Mrs. Noah strongly objected to her husband's intention to take the elephants on board, fearing that their weight woud cause a dangerous displacement of the ark's metacenter. How this domestic difference was composed we had no opportunity of learning, for as the chairman, whose expression combined sympathetic amusement with mild deprecation, was rising and about to protest, Dr. Haughton, anticipating the result, had already turned towards the door, telling us over his shoulder that he was on his way to make a fuller communication on the subject to the Anthropological Section.

After this brief description of an event, which I hope you will agree ought not to be forgotten, we must return to organic evolution and to one of the most important subjects debated at any time before a meeting of the British Association—the question, "Are Acquired Characters Hereditary?"—brought before the world by Professor August Weismann, who was present at Manchester and spoke in the discussion (unfortunately not reported), introduced by Ray Lankester, in which Dr. Hubrecht, Patrick Geddes, Marcus Hartog and the present speaker took part. Weismann's conclusion that "acquired characters" are not inherited, was held by Professor Goodrich, in his address to Section D at Edinburgh in 1921, to be "the most important contribution to the science of evolution since the publication of Darwin's 'Origin of Species,'" an opinion with which the great majority of biologists will agree, although the terms employed for the two classes, the inherited and the non-inherited, together with the ideas underlying them, were shown by Adam Sedgwick, at Dover, in 1899, Archdall Reid, and others, as well as by Goodrich himself, to be incorrect. Nevertheless it will probably be impossible to abondon the word "acquired," employed by Erasmus Darwin (1794), Lamarck (1809), and Prichard (1813) as well as by later authorities. Whenever environmental conditions are followed by characteristic changes, absent when these conditions are absent; or when such changes

[14] *Ibis*, pp. 429–433, October, 1859.

follow the use or disuse of the parts of an organism, or the education it has received, then we have before us the "acquired" characters maintained by Weismann to be incapable of hereditary transmission. This vital conclusion, accepted, as I believe it is, by nearly all biologists, is not appreciated as it ought to be by the general public. A brief statement of a single piece of evidence may convince some who are doubtful about a conclusion with which human life is very deeply concerned.

My old friend, the late A. A. Macdonell, professor of Sanskrit at Oxford, spoke two languages, English and German, as they are spoken by native Englishmen and Germans. I asked him whether he thought it was possible for any mature person to learn a foreign language so perfectly that he would be mistaken for a native. He replied that he was sure it could not be done and that his own ability to speak the two languages as he did had been only made possible because as a small child he had been continually taken backwards and forwards between the two countries. Yet any human being transported as a baby from his own country to another and brought up there among the natives will learn to speak as they speak. All the past generations, however many, during which his ancestors spoke the language of his birthplace, will count for nothing, will not retard his acquisition of another tongue or modify it in any way.

An interesting and amusing example is provided by the futile striving of an Englishman to pronounce the Welsh double-l, generally attempted by the substitution of "th." And even the advice given by a Welsh clergyman to the English Bishop of his diocese is unlikely to bring success: "You must put the tip of your Right Reverend tongue against the roof of your Right Reverend mouth, and hiss like a goose."

The result of education as an "acquired" character in the Weismannian sense is of such special importance that I think it is well to quote the conclusions stated by Ray Lankester in his address to the seventy-fifth meeting of the association at York. He then maintained that the "power of building up appropriate cerebral mechanism in response to individual experience, or what may be called 'educability,' is the quality which characterises the larger cerebrum, and is that which has led to its selection, survival, and further increase in volume . . . 'Educability' can be transmitted; it is a congenital character. But the *results* of education can *not* be transmitted. In each generation they have to be acquired afresh. . . . On the other hand, the nerve-mechanisms of instinct are transmitted, and owe their inferiority as compared with the results of education to the very fact that they are *not* acquired by the individual in relation to his particular needs, but have arisen by selection of congenital variation in a long series of preceding generations."[15]

Lankester was led by these conclusions to reject altogether the theory of G. H. Lewes, G. Romanes and others, "that instincts are due to lapsed intelligence," a theory also disproved by Lloyd Morgan's observations on young birds described by him at the Ipswich meeting in 1895.[16] Another very important subject brought forward by Lankester was the evidence, originally published by him in 1894,[17] that Lamarck's first and second laws of heredity "are contradictory the one of the other, and therefore may be dismissed." His statement may be briefly summarized as follows:

The first law assumes that in spite of thousands of generations during which a normal environment has moulded the individuals of a given species of organism, and determined as each individual developed and grew "responsive" quantities in its parts (characters); yet, as Lamarck tells us, and as we know, there is in every individual born a potentiality which has *not* been extinguished. Change the normal conditions . . . and (as Lamarck bids us observe), in spite of all the long-continued response to the earlier normal specific conditions, the innate congenital potentiality shows itself. The individual . . . shows *new* responsive quantities in those parts of its structure concerned, new or acquired characters. . . .

So far, so good. What Lamarck next asks us to accept, as his "second law," seems not only to lack the support of experimental proof, but to be inconsistent with what had just preceded it. The new character which is *ex hypothesi*, as was the old character . . . which it has replaced—a response to environment . . . is, according to Lamarck, all of a sudden raised to extraordinary powers. The new or freshly acquired character is declared . . . to be capable of transmission by generation; that is to say, it alters the potential character of the species. It is no longer a merely responsive or reactive character, determined quantitatively by quantitative conditions of the environment, but becomes fixed and incorporated in the potential of the race, so as to persist when other quantitative external conditions are substituted for those which originally determined it.

The effect of Lamarck's laws on the hereditary transmission of acquired characters would be this: "a past of indefinite duration is powerless to control the present, while the brief history of the present can readily control the future."

After hearing a very condensed statement of conclusions so essentially bound up with the progress of organic evolution, I feel sure that you will wish to be reminded of Professor Ewing's words which followed

[15] Report, British Association, pp. 26–27, 1906. The conclusions here quoted had been communicated to Société de Biologie of Paris, in 1899 (Jubilee Volume) and were reprinted in *Nature*, lxi: pp. 624–625, 1900.

[16] Report, British Association, p. 734.

[17] *Nature*, li: p. 127, 1894; Report, British Association, pp. 29, 30, 1906.

the address at York: "Now is the winter of our discontent made glorious summer by this Ray of Lankester."

Returning to the unreported discussion on the inheritance of acquired characters at Manchester, I venture to bring forward certain observations opposed to a belief in Lamarckian evolution by means of inherited experience—observations which I then described and have not known to be answered. In the relationship between enemy and prey there is very commonly no opportunity for the latter to learn by experience. The wonderfully elaborate adaptations by which sedentary insects are hidden from enemies have been evolved, not by experience of enemies but by avoidance of enemies. In these examples, and they are numberless, we are driven to accept Weismann's conclusion and with him to invoke "the all-sufficiency of Natural Selection." When one of the twig-like caterpillars, of which there are so many in this country, is detected by an insectivorous bird it can do nothing and is devoured at once. Its one defence is the astonishingly perfect resemblance to a twig of the bush or tree on which it lives. It is firmly fixed and its weight also supported by an almost invisible thread so that it can not escape as many caterpillars do by dropping to the ground and sheltering in the grass or among dead leaves. Its one chance of survival is to gain so perfect a disguise that it will not be seen, and to gain this end the adaptive devices are most elaborate and wonderful: its twig-like shape and colors with the power of gradually adjusting these so as to resemble the bark of the bush or tree on which the parent moth laid the egg from which it came, even the power to reproduce exactly the appearance of lichen, the rigid stick-like attitude maintained during the hours of daylight. Finally there is the evidence, recently obtained by Robert Carrick,[18] that the disguise *does* protect; for examples of one of these caterpillars, resting on a branch of its food-plant fixed over a wren's nest containing young, were unnoticed by the parent bird which used the same branch as a convenient perch; yet seen and at once taken when placed on a white surface below.

One of the best examples of a prophetic instinct is to be found in the larva of an African Tabanid fly (*T. biguttatus*). This maggot lives and feeds in soft mud which, during the dry season when the chrysalis stage has been reached, will be traversed in all directions by wide and deep cracks in which insectivorous animals can search for prey. But the maggot, while the mud is still soft, prepares for this danger. By tunnelling spirally up and down it makes a line of weakness which will cause a pillar to separate from the mass when the mud hardens and contracts. It then tunnels into the still soft pillar and becomes a chrysalis in the center of its deeper end. However wide the cracks which appear in the mud, the maggot has arranged beforehand that they will not invade its cylinder. Dr. W. A. Lamborn, who made this most interesting discovery, observed that the summits of the pillars, forming circular discs of about the size of a penny, scattered here and there over the surface, were never thus traversed, but that an empty shell was protruding from the center of each when the fly had emerged.[19] My friend the late Professor J. M. Baldwin, the distinguished American psychologist, well remembered at many of our meetings, wrote when he heard of this discovery: "it seems *complete*—one of those rare cases of a single experience being sufficient to establish both a fact and a reason for the fact! It is beautiful."

I would ask any believer in Lamarckian evolution, or in Hering's and Samuel Butler's theory of unconscious memory residing in the germ-cells, how it would be possible to explain these prophetic instincts, adapted not to meet but to avoid future experience, except by the operation of natural selection.

The appeal of orthogenesis, or internal developmental force, as the motive cause of evolutionary progress has often been made—generally by paleontologists rather than by the observers of living forms. Any such belief in the potency of an internal tendency is, I think, open to the criticism made by Thistleton Dyer in his address to Section D at Bath in 1888:

> This appears to me much as if we explained the movement of a train from London to Bath by attributing to it a tendency to locomotion. Mr. Darwin lifted the whole matter out of the field of mere transcendental speculation by the theory of natural selection, a perfectly intelligible mechanism by which the result might be brought about. Science will always prefer a material *modus operandi* to anything so vague as the action of a tendency.

It is not necessary for me to speak on the rediscovery of Mendel's great work and all that it has meant to our biological sections in the early decades of the present century. The recent developments, following the work of Haldane, R. A. Fisher and others, and the vitally important relationship between Mendelism and natural selection were brought before us last year in Julian Huxley's illuminating address to Section D. The older belief that only large variations, or mutations as they then began to be called, were subject to Mendelian inheritance, and that small variations were not inherited at all, disappeared when further researches proved that extremely minute differences were "heritable in the normal Mendelian manner,"[20] and, with this, the foundation of Darwinian evolution became immensely strengthened. It

[18] *Trans. Roy. Ent. Soc., Lond.*, 85: part 4, p. 131, 3 pls., May, 1936.

[19] *Proc. Roy. Soc.*, B, 106: p. 83, pl. v, 1930; *Proc. Ent. Soc., Lond.*, v: p. 14, 1930.

[20] Report, British Association, p. 77 and references quoted, 1931.

is also right to remember that Bateson, the leader of Mendelian research in this country, always believed in natural selection, regarding it indeed as self-evident and not very interesting. Also that Ray Lankester, as long ago as his 1906 address at York, maintained that however far Mendelism was advanced it "would not be subversive of Mr. Darwin's generalisations, but probably tend to the more ready application of them to the explanation of many difficult cases of the structure and distribution of organisms."

The relationship between the germinal foundation of Mendelian and Weismannian heredity was considered in a paper by L. Doncaster read before Section D at the South African meeting in 1905. He then maintained that Weismann's "hypothesis that the material bearer of hereditary qualities is the chromatin of the nucleus" of the germ-cells had been confirmed by recent work on their maturation which "has shown that they contain a mechanism which seems precisely adapted to bring about that segregation of characters which forms the most fundamental part of the Mendelian theory, and it seems hardly possible that the two things are unconnected." MacBride also in his address to the same section at Newcastle in 1906 spoke of the "great epoch-making discovery of experimental embryology, *viz.*, the existence of *specific organ-forming substances.*" These fundamental discoveries bring to mind a conversation with Weismann when he had been finally driven to frame and elaborate this hypothesis, and was so appalled by the number and minuteness of the material bearers of hereditary qualities contained in a single-germ-cell that, as he told me, he could not believe that the physicists and chemists were correct in their conclusions about the size of the atom. He admitted that diverse lines of evidence led to the same result, but even so, he believed the future would prove that physicists were mistaken and that the atom was far smaller.

It is impossible to say more than a few words about the very interesting and important discussion on "the present state of the theory of natural selection" held at the Royal Society on May 14 last year. The subject was approached from many points of view by both zoologists and botanists, and their conclusions were very welcome to Darwinians who remembered the earlier opinions expressed when Mendel's great work was rediscovered. I think, however, that Professor D. M. S. Watson, in the opening address, was inclined to underestimate the value of the existing evidence for a "selective death rate," although every one will agree that "any new evidence . . . or indeed any suggestion of cases which might be capable of investigation" would be most desirable.

I may briefly mention a few experiments brought before Section D at the Bristol meeting in 1898 beginning with the work of Weldon and Thompson on the common shore crab, showing that the effect of china clay and other impurities in the sea at Plymouth was selective and promoted changes of shape which ensured that the water flowing over the respiratory surface was more efficiently filtered.

Then, on the subject of chance, the heroic help rendered by Mrs. Weldon, who four times recorded the result of 4,096 throws of dice, showing that the faces with more than three points were on the average uppermost slightly more often than was to be expected. It comes back to me very clearly because of the interesting explanation—that the points on dice are marked by little holes scooped out of the faces, and that points 6, 5 and 4, respectively opposite 1, 2 and 3 are somewhat lighter, more of the ivory having been removed; also because of Francis Galton's delight and his humorously expressed wonder whether the facts had been realized by those who had an interest other than scientific in the throwing of dice.

Experimental evidence was also submitted by Miss Cora B. Sanders (Mrs. C. B. S. Hodson) and myself, proving that when the rough angular pupa of the small tortoiseshell butterfly "is suspended from a surface against which it stands out conspicuously, it is in far greater danger than when it is fixed to one upon which it is concealed."

To the observer of living creatures, however, the most convincing evidence is provided by animals themselves. When a wild bird is seen to capture some conspicuous butterfly or moth and then immediately to reject it the association between inedibility and a warning color is more convincingly suggested than when insects are offered to animals in confinement, although such experiments are of great value and often provide the only available evidence. There are, however, instances in which abundant data for statistical investigation are furnished by the wild animals themselves. Thus the long-eared bat has the convenient habit of eating moths —its regular food—while it hangs suspended from a surface to which it returns after each capture; and as the wings are rejected, these may be collected in large numbers, yielding valuable information on the significance of concealing and warning patterns.

In the attempt to determine the motive causes of organic evolution, the work of the naturalist, the student of living nature, is essential. His task is to do what Lyell did for geology by directing attention to the forces now in operation and seeking with their help to interpret the past, and in this work it is especially valuable to study adaptations which have been developed in recent times and can, in certain instances, be proved to undergo changes even now. Thus the interesting observations of H. Lyster Jameson showed that a pale local race of the common mouse had been formed, although incompletely, in from 100 to 125

years, by the selective attacks of owls and hawks on sandhills near Dublin.[21] I therefore believe that the color of animals provide one of the most fruitful fields in which to pursue these investigations, and I regret that this work has been recently attacked by an American zoologist who, referring to the recent revival of natural selection, continues—"if the doctrine can emerge minus its sexual selection, its warning colors, its mimicry and its signal colors, the reaction over the end of the century will have been a distinct advantage."[22] It is of course impossible to discuss, on the present occasion, this confident attempt to depreciate the value of work associated with the names of Bates, Wallace, Trimen and Fritz Müller. I will only point out that their conclusions on warning colors and mimicry have been immensely strengthened and confirmed by the later observations of Guy Marshall, W. A. Lamborn, St. Aubyn Rogers, Hale Carpenter, V. G. L. van Someren and others in Africa; by the experiments conducted by some of these naturalists, and also by H. B. Cott and R. Carrack, and in the United States by Morton Jones.

It is interesting to remember that a paper by two American entomologists[23] was among the first to accept and support by fresh observations the conclusions brought forward by H. W. Bates in his great memoir on the mimetic butterflies of the Amazon Valley,[24] and that one of the authors treated the same subject more completely in a later paper[25] much appreciated by Darwin.[26]

It is also important to remember that the above-mentioned conclusions have been reached by the study of marine animals no less than terrestrial, as was shown by Herdman in his address to Section D at Glasgow in 1901, and by his experiments communicated to the same section at Ipswich in 1895; also that Garstang, with his very long and intimate experience of marine life, adopts the same interpretation of color and form with the associated attitudes and movements.

If time permitted it would be possible to speak of numerous papers on mimicry and the related subjects which have been brought before our meetings. It is impossible to attempt this now, but many will feel with me that the name of the late Dr. F. A. Dixey should not be forgotten—one who attended so regularly, so often read papers at our meetings, presided over Section D at Bournemouth in 1919, lectured at Leicester in 1907, always giving the results yielded by the study of his favorite insects, and their interpretation by the theory of natural selection; also one who delighted in the social gatherings of his section, where his rendering of "Widdicombe Fair" will be long remembered.

In my concluding remarks I am anxious to refer to a very interesting and encouraging subject—the feeling for animals and the care for their welfare to-day, as contrasted with the treatment they received a hundred years ago and even in the youth of many among us. Only last autumn *The Times* of October 12 reported that 1,000 swallows had arrived at Venice "sent there by bird-lovers from Vienna and Munich in order to save them from the effects of the cold weather. Soon after their arrival they were set free and flew south along the Adriatic coast." And a little earlier the writer of the amusing "Fourth Leader" referred to a meeting of the Society for the Preservation of the Fauna of the Empire at which the care of the opossum was discussed, comparing this with the report of happenings a hundred years earlier when there was a "humorous debate" at the Zoological Society "about puffing cigar-smoke into the cages of the monkeys," to their evident discomfort. The writer, yielding too far, we hope, to the depression of the present day, concludes: "The world, it may be, is 'man-sick' and yearning to be rid of a bad mistake. But the creature cannot be wholly vile when instead of torturing monkeys it takes thought for the opossum." It would not be right to quote from a century-old report without speaking of all that is done and has been done during many years for the care and health of animals by the great London society, and in doing this, for the education and happiness of our people. But the change of which I have spoken is most deeply impressed on those who remember, as many of us do, the misdirected hours in youth when birds were shot in our gardens and brick traps made to catch them. I feel sure that those who did these things are not essentially different from their children and grandchildren who have grown up in a kinder atmosphere. I must not occupy more time on a subject which to some may seem inappropriate, but it is bound up with education in its true sense—a leading out—and if, as Ray Lankester said at York, and we are all coming to believe, the hidden powers within *are* inherited while the results of their development are *not*, then there is no easing of the burden with the passage of time, but each generation afresh must bear the heavy responsibility of conducting this development in the best way so that its successor may be able to meet the changing and, at this time, the increasing needs. The relationship between the powers within and their development was suggested in arresting words by the late Professor Scott Holland: "To say that a man cannot be made good by Act of Parliament is such an obvious truth that people forget what an outrageous lie it is!

[21] *Jour. Linn. Soc.* (Zool.), 26: p. 465, pl. 30, 1898.
[22] "Evolution." A. Franklin Shull. New York, 1936.
[23] Walsh and Riley, "The American Entomologist," St. Louis, Mo., vol. i, p. 189, 1869.
[24] *Trans. Linn. Soc., Lond.*, xxiii: p. 495, 1862.
[25] Riley, "Third Annual Report on the Noxious . . . Insects of . . . Missouri," p. 142, 1871.
[26] "Charles Darwin and the Theory of Natural Selection" (Poulton, 1896), p. 202.

Thoughts on the development of these hidden powers by the educating influence of social environment suggest the greatest of the problems by which we are faced—the end of international war. Michael Foster, in his address at Dover in 1899, after speaking of progress in the material of warfare was led to believe that, "happily, the very greatness of the modern power of destruction is already becoming a bar to its use, and bids fair—may we hope before long?—wholly to put an end to it; in the words of Tacitus, though in another sense, the very preparations for war, through the character which science gives them, make for peace." And in his concluding pages he expressed the hope that the brotherly meeting between the English and French Associations at Dover and Boulogne might be looked upon as a sign that science, by nobler means than the development of armaments, was steadily working towards the same great end. And, in a time of still greater need and perplexity, may we not, in the same hopeful spirit, look upon the recent visit by which members of the French Association have honored us, and feel strengthened in the belief that the great end will be reached.

There are, I know, very many people who look upon the great war with later wars and rumors of wars as the close of Michael Foster's dream. The words in which Sir Arthur Schuster concluded his address at Manchester in 1915, and Sir Edward Thorps at Edinburgh in 1921, indicate, I hope, that the British Association does not thus despair, and in this belief I bring before you a passage from the far earlier address which Sir Richard Owen delivered to the twenty-eighth meeting at Leeds in 1858—a passage which makes a special appeal at a time when the British and American Associations are confidently hoping to strengthen still further the bonds of sympathy and mutual appreciation by which they have been happily united for so many years.

Referring to the transatlantic telegraph Sir Richard said:

> We may confidently hope that this and other applications of pure science will tend to abolish wars over the whole earth; so that men may come to look back upon the trial of battle between misunderstanding nations, as a sign of a past state of comparative barbarism; just as we look back from our present phase of civilisation in England upon the old border warfare.

Confident words inspired by the forging of a new link between the two great English-speaking nations. Nearly eighty years have passed since they were spoken, but with all the terrible disappointments there has been great progress, and a time will surely come, and may it come quickly, a time which shall prove that the visions of the young and the dreams of the old were prophetic of a glorious reality.

OBITUARY

VERNON LYMAN KELLOGG

VERNON LYMAN KELLOGG was born on December first, 1867, at Emporia, Kansas, close both to the place and the date of birth of his intimate, life-long friend, William Allen White, two men who between them have given that little Kansas town a noteworthy place in the history of America. Graduating from the University of Kansas in 1889, he took the next four years to prepare himself for the life of a zoologist, his studies being conducted at the University of Kansas, Cornell, Leipzig and Paris. In the quarter century from 1894 to 1920 he worked in close association with David Starr Jordan at Stanford University, where he was "professor of entomology and lecturer in bionomics." During this period he wrote eight books, most of them in collaboration with Dr. Jordan, on various aspects of zoology. These gave him his taste and revealed his talent for effective writing.

The war changed completely the course of Kellogg's life. Through his acquaintance with Herbert Hoover he became active and influential in the relief work in Belgium. Through his "Headquarters Nights" (1917), "The Food Problem" (1917), "Fighting Starvation in Belgium" (1918), "Germany in the War and After" (1919), "Herbert Hoover, the Man and his Work" (1920), he sprang into prominence as one of the effective political writers of the war period, while his administration of relief in Belgium (1915–16) and in Poland and Russia (1918–21) brought him recognition from France, Belgium and Poland. He was made an officer of the Legion of Honor (France), Commander of the Order of the Crown (Belgium), Commander of the Order of Polonia Restituta (Poland), Commander of the Order of Leopold I (Belgium), and Recipient of the National Gold Medal (Poland).

Kellogg never returned to academic life. Indeed his period of greatest influence and accomplishment began in 1919, when he became permanent secretary of the National Research Council, and from then until the time of his retirement in December, 1931, through his building up of that organization, through his service as trustee and member of the executive committee of the Rockefeller Foundation, trustee of the Brookings Institution, trustee and chairman of the executive committee of Science Service, member of the National Academy of Sciences, member of the executive committee of the American Association for the Advancement of Science, etc., and his continuous series of

contributions to the *Atlantic Monthly* and others of our literary journals, he exerted a potent influence upon the evolution of American scientific life.

When about 1930 he found himself stricken with the incurable malady known as Parkinson's disease, the quiet fortitude with which, with unimpaired mind but failing body, he faced this sentence won the admiration of all who knew him intimately. On August 8, in the sanitarium at Hartford, Connecticut, four months before he had reached his threescore years and ten, Vernon Lyman Kellogg left the scenes in which he had played an active and a worthy part in a momentous period of American life.

ROBERT A. MILLIKAN

SCIENTIFIC EVENTS

EXPEDITIONS OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA

THE Academy of Natural Sciences of Philadelphia has nineteen expeditions in the field gathering new material for study and for museum display. One expedition, led by Dr. Edgar B. Howard, acting curator of the department of geology and paleontology of the academy, has unearthed a small and perfect stone point that is presumably the work of Folsom Man, near Portales, New Mexico. Near the locality in which this expedition is working, James A. G. Rehn, his son, John W. H. Rehn, and Vernon S. L. Pate, of Cornell University, are collecting grasshoppers, wasps, mantids and earwigs.

Dr. Francis W. Pennell, curator of the department of botany, is collecting plants along the portion of the trail made by the Lewis and Clark expedition in the Bitterroot Mountains between Idaho and Montana. Dr. Walter M. Benner, associate in the botanical department, is making a general survey of plant life south of Dr. Pennell's work in Colorado, Nevada, Utah and California. M. A. Carriker, Jr., of the academy, and Gordon Howes are continuing their three-year study of the migration and distribution of the birds of Bolivia.

There are four separate expeditions of field workers gathering a representative collection of fish from the West Indies, the eastern portion of the United States and the Pacific. Laurence L. Reeve, of Haverford, Pa., is working on the Island of Mona, off Puerto Rico, and Henry W. Fowler, curator of the department of fishes, is gathering further material in Pennsylvania, Virginia and New Jersey for his forthcoming publication on the fishes of northeastern North America.

As reported in SCIENCE for August 13 the George Vanderbilt expedition brought back from the Southern Pacific extensive collections of fish, birds and plants. Frederick Crockett, of Boston, who is leading an expedition to Dutch New Guinea, collected on islands along the route of the Vanderbilt expedition during the late spring and early summer. Four expeditions are concentrated on the study and collection of mammals in Panama, Mexico, the West and the Yukon Territory. Shells and invertebrates are the subject of two field trips; Dr. Henry Pilsbry, curator of the department of mollusks, worked in Florida during part of the winter months, and in the West Indies, a joint project of the Museum of Comparative Zoology in Cambridge and the academy is making a study of land shells.

Other members of the staff who are engaged in collecting include Samuel Gordon, associate curator of minerals, who has gathered specimens from Vermont; John W. Cadbury, who is making collections of insects in the New Jersey pine barrens, and James Bond, of the department of birds, who completed work on the study of West Indian birds during his thirteenth trip this past winter. Collections of fishes and birds have been received at the academy from collectors stationed in Siam.

THE HOLDEN EXPEDITION OF THE AMERICAN MUSEUM OF NATURAL HISTORY

AN expedition led by Dr. William Ball Holden, staff surgeon of the American Museum of Natural History, left New York on August 21 to carry on scientific exploration in the Amazonian jungles of South America. The expedition will maintain contact with the outside world from the interior of British Guiana and Brazil by means of direct linkage with the National Broadcasting Company, and will attempt to chart its course through the jungle by means of special radio equipment.

In addition to Dr. Holden, the members of the party will include Dr. A. C. Smith, associate curator of the New York Botanical Garden; Robert Snedigar, of the department of herpetology of the American Museum of Natural History; William G. Hassler, official photographer; Neil MacMillan, field assistant, and Orison W. Hungerford, radio engineer.

The main object of the expedition, which is expected to take about six months and to remain in the jungle for about three months, will be to carry out an intensive study of the diseases and drugs of the Indian tribes which live along the northern tributaries of the Amazon River. At the same time the other members of the party will collect reptiles, amphibians, small mammals and insects as well as botanical specimens. The section to be explored is the little known Sierra

Akarai range of mountains in the southernmost portion of British Guiana along and within the Brazilian border.

On reaching Georgetown, British Guiana, the expedition will embark on two specially built river boats. The party will travel far into the interior to establish a base camp about 600 miles from the coast. At this camp the main radio equipment will be installed, which has been constructed to allow for humidity and high temperature. Direct communication with Riverhead, Long Island, will be maintained. The route branches off to the west toward Venezuela, then south through the gorges of the Kanaku Mountains. About 150 miles up the Rupunnuni, the party will reach the village of John Melville, the half-Scottish, half-Indian chief of the Wapisianni tribe. At this point, not far from Dadanowa and Wichabei, Dr. Holden will offer his first broadcast from the interior, which will be heard over the National Broadcasting Company network. Thereafter the progress of the expedition will be described once or twice weekly.

The party will leave its boats and travel about 65 miles to the Kissikityu River and down the river by native dugouts until the waters again join the Essequibo. After a short distance along the Essequibo, the base camp will be established. Most of the members of the party will conduct their investigations within about a day's traveling distance from this camp, but Dr. Holden, with Mr. Hassler and a group of Indians, will travel across the frontier of Brazil, making their way through the tropical rain-forest.

THE A. W. MELLON EDUCATIONAL AND CHARITABLE TRUST

THE residue of the estate of the late Andrew W. Mellon is bequeathed to "the A. W. Mellon Educational and Charitable Trust," which was established in December, 1930. With the exception of bequests amounting to $180,000 to his personal employees, in appreciation of their loyalty and efficiency, and such household effects as are contained in his residence, the entire estate will go to charitable and educational purposes.

In explanation of his reason for making no bequests to his children, Mr. Mellon stated that they already had been adequately provided for. His son, Paul Mellon, his son-in-law, David Bruce, and his attorney, Donald D. Shepard, who are the surviving trustees of the A. W. Mellon Educational and Charitable Trust, were named as executors under the will.

It is provided that the funds and properties of the trust be "administered and operated exclusively for the benefit of, and the trust estate shall be distributed by the trustees exclusively in aid of such religious, charitable, scientific, literary and educational purposes as shall, in the judgment of the trustees, be in furtherance of the public welfare and tend to promote the well-doing or well-being of mankind and/or for the use of the United States, any state, territory, or any political subdivision."

Up to April, 1935, five years after it was established, the trustees had distributed $255,443 for religious, charitable and educational purposes and have bought $34,300 worth of pictures. Contributions or gifts were made to thirty-seven separate organizations. The trust by 1935 received rare paintings which cost $19,000,000 and $1,250,000 in cash and securities. Of that amount Paul Mellon gave $191,000.

The paintings, valued in the neighborhood of $50,000,000, have since been given to the Government for a national art gallery. Mr. Mellon gave more than $10,000,000 for a building, for which ground is now being cleared in Washington.

It is reported that the estate, which is estimated at from seventy-five to two hundred million dollars, will not be subject to federal or state inheritance taxes.

PROPOSED BUILDINGS FOR THE NATIONAL INSTITUTE OF HEALTH

PLANS for the construction of three new buildings to provide better facilities for the National Institute of Health have been announced and are described in the *Star,* Washington.

The buildings will be erected on a 45-acre tract of wooded land, 1½ miles beyond Bethesda, Md., on the Rockville highway. The property was donated to the United States Public Health Service for this purpose in 1935 by the late Luke I. Wilson, of Washington. A total allotment of $1,143,000 from the emergency construction program acts of 1934 and 1936 is available for construction. The National Cancer Institute, recently authorized by Congress, probably will be built on the same tract of land and its work coordinated with that of the National Institute of Health.

The three new buildings involved in the present plans will be erected on the central high plateau of the 45-acre tract, beyond a small ravine. A roadway on the north side will lead to the buildings from the Rockville highway. They will serve as the nucleus for a projected national research center and will house activities of the National Institute of Health which are now scattered at different places. The plans make provision for the future construction of two more buildings in the group. The institute will retain its present headquarters at Twenty-fifth and E streets until completion of the latter group.

The structures will be of Georgian design, with exterior brick walls, stone trim and pitched hip slate roof, fireproof throughout. There will be a modern air-conditioning and air-heating system. Each building will consist of basement, subbasement, three stories and attic.

The central Administration and Field Office Building of the institute, having a frontage of 186 feet and a depth of 100 feet, will be flanked by an industrial hygiene laboratory building and a public health methods building. Administrative offices will be on the first floor of the central building of the group, with a library, study and work rooms on the second floor and a lecture room, cafeteria, dental and photographic units on the third floor.

The Industrial Laboratory and Public Health Methods Buildings will be identical in size and design, 150 feet long and 48½ feet wide. Mechanical and power units for the entire group will be in the subbasements of these two buildings. Except for offices on the first floor, most of one building will be devoted to laboratory space. The Methods Building will house numerous activities, including child hygiene and work in chronic diseases, and will provide space for the inoculation of animals in the preparation of various vaccines.

GRANTS-IN-AID FOR PUBLIC HEALTH WORK

THE *Journal* of the American Medical Association reports that the Treasury Department Appropriation Act for the fiscal year ending June 30, 1938, appropriated $8,000,000 to assist states and their political subdivisions to establish and maintain adequate public health services, as authorized by the Social Security Act. This sum, plus balances of approximately $1,000,000 from previous appropriations not used by the states, will be allotted to the several states under regulations recently promulgated by the surgeon general of the Public Health Service. These regulations provide that of the total sum available 30.7 per cent. will be allotted to the states in the ratio which the population of each state bears to the population of the United States; 38.6 per cent. on the basis of special health problems, such as, for example, high morbidity or mortality from particular causes on a state-wide basis, as malaria, hookworm, bubonic plague, trachoma and typhus fever, and the remainder, or 30.7 per cent., on the basis of financial need.

To obtain allotments, a state must present to the surgeon general of the Public Health Service a comprehensive statement showing the present state health organization, programs and budget and a proposed plan for extending and improving the administrative functions of the state department of health and for extending and improving local health services. Each state health officer must submit to the surgeon general, for his approval, proposed budgets for carrying out each contemplated project, showing the sources, purposes and amounts of all funds, the amounts requested from the Public Health Service for the fiscal year and such other information relating to the proposed projects as the surgeon general may require. Each state health officer is furthermore required to certify that state and local expenditures will not be replaced or curtailed through the use of federal funds.

Allotments to states will be available for payment when matched by state or local public funds. The surgeon general, however, may in his discretion waive the matching requirement in those states wherein the per capita appropriation for the state department of health, exclusive of funds for the maintenance of institutions, exceeds the average per capita appropriation of all the states for the same purposes.

Payments to the states will be made in quarterly instalments. Each state health officer must submit to the surgeon general a quarterly project financial report for each budget in force and a consolidated quarterly report summarizing all budgets. The reports must show the amount of public health funds actually expended and the actual expenditure of state and local funds and must contain such other information as the surgeon general may require. Each state health officer must, furthermore, make quarterly reports of activities, including (*a*) a report on the activities of the central administration and service projects, (*b*) a copy of the progress report from each local health project and (*c*) a consolidated summary report for all projects.

THE SECOND NATIONAL CONFERENCE ON EDUCATIONAL BROADCASTING

THE Second National Conference on Educational Broadcasting will be held at the Drake Hotel in Chicago, on November 29, 30 and December 1.

The objectives of the conference, as formulated by a committee, are as follows:

To provide a national forum where interests concerned with education by radio can come together to exchange ideas and experiences.

To examine and appraise the situation in American broadcasting as a background for the consideration of its present and future public service.

To examine and appraise the listeners' interest in programs that come under the general classification of public service broadcasting.

To examine the present and potential resources of education through radio.

To examine and appraise the interest of organized education in broadcasting.

To bring to a large and influential audience the findings that may become available from studies and researches in the general field of educational broadcasting, particularly such studies and researches as may be conducted by the Federal Radio Education Committee.

In addition to the eighteen organizations which sponsored the first conference, the following have been selected to sponsor the second, to increase the scope of the social and cultural interests which will be repre-

sented on a nation-wide basis: American Association for the Advancement of Science, American Association of Museums, American Association of University Women, American Federation of Arts, American Library Association, American Public Health Association, Music Educators National Conference, National Council of Parent Education, National Federation of Music Clubs and the National University Extension Association.

The American system of broadcasting, an evaluation of broadcasting from the point of view of the listener, educational broadcasting, and the future of radio have been selected as the topics of the four general sessions. Speeches on these subjects will be made by prominent representatives of education, the radio industry and the listener, and will be followed by periods of open discussion.

To give unity and continuity to the conference one person has been designated as leader of all the discussions which follow the general sessions. Dr. Lyman Bryson, of Teachers College, Columbia University, has accepted this responsibility.

Each afternoon will be devoted to section meetings in which specialists in the various fields covered in the general sessions will discuss specific aspects of each of these topics. At the banquet on the second evening, the speakers will discuss the international significance of radio.

Dr. George F. Zook, president of the American Council on Education, will again act as chairman. Dr. C. S. Marsh, vice-president of the council, is the executive secretary, and his office at 744 Jackson Place, Washington, D. C., is the headquarters for preparations. Carl Milam, secretary of the American Library Association, is chairman of the Chicago Committee on Arrangements.

SCIENTIFIC NOTES AND NEWS

DR. HARVEY CUSHING, Sterling professor of neurology emeritus in the School of Medicine of Yale University, has been appointed director of work in the history of medicine with the rank of professor.

IT is proposed to organize at the University of Michigan the Mortimer E. Cooley Foundation of Engineering, in honor of the dean emeritus of the College of Engineering, who has been a member of the faculty for forty-seven years. The object of the foundation is to provide funds to supplement state support for the financing of salaries of eminent teachers, the appointment of fellows and the provision of facilities and equipment.

ACCORDING to *Industrial and Engineering Chemistry* the American Electroplaters Society has awarded its gold medal to Harry P. Coats, of the Firestone Steel Products Company, Akron, Ohio, for presenting what was judged to be the best paper, "Brass Plating for Rubber Adhesion," on electrodeposition printed during 1936.

LÁSZLÓ ZECHMEISTER has been awarded the 1936 medal of the Hungarian Academy of Sciences, for his investigations in the field of the chemistry of carotenoids and polysaccharides.

THE Pasteur medal given by the Chemical Society of France jointly with the Society of Biological Chemistry, Paris, has been awarded to Dr. Adolf Butenandt, who was recently appointed director of the Kaiser Wilhelm Institute for Biochemistry at Berlin-Dahlem.

Nature states that M. Léon Guillet, director of the École Centrale des Arts et Manufactures and professor at the Conservatoire des Arts et Métiers, Paris, has been nominated an honorary vice-president of the British Iron and Steel Institute.

DR. LAURENCE H. SNYDER, of the Ohio State University, was elected president of the Eugenics Research Association at its recent annual meeting in New York City. Other officers elected were as follows: *Honorary president,* Charles B. Davenport; *Vice-president,* H. B. Fantham; *Secretary-Treasurer,* H. H. Laughlin.

AT Northwestern University appointments have been made as follows: Dr. Lewis H. Tiffany, of the department of botany, has been made head of the department; Dr. Harold T. Davis, for the past year head of the Cowles Commission for Research at Colorado Springs, professor of mathematics, and Dr. Robert H. Seashore, of the University of Southern California, associate professor of psychology.

DR. EVANS W. MCCHESNEY, associate professor of biological chemistry at the School of Medicine of the University of North Carolina, has resigned to join the faculty of the College of Medicine of Baylor University, Dallas, Texas. Dr. Augustus S. Rose, associate professor of anatomy, has become assistant in neurology at the Massachusetts General Hospital, Boston.

DR. ROY M. DORCUS, associate professor of psychology at the Johns Hopkins University, has resigned to accept a position in the University of California at Los Angeles. He will be associated with Dr. Knight Dunlap, who resigned in 1935 as professor of experimental psychology at the Johns Hopkins University.

N. H. MANDERFIELD, acting head of the department

of metallurgy at the Michigan College of Mining and Technology, has been promoted to a professorship. Other promotions include: to assistant professorships, J. M. Gaffney and W. A. Longacre, mathematics and physics; E. J. Townsend, civil and mining engineering, and W. B. Gertz, metallurgy and ore dressing. New instructors include: H. K. Burr, chemistry; G. R. Elwell, mechanical engineering; Alex Belda, mechanical drawing, and V. O. York, physics and mathematics.

DR. DANIEL NICHOLSON, assistant professor of pathology at the University of Manitoba, has been appointed professor of pathology to succeed Dr. William Boyd, who has become professor of pathology at the University of Toronto.

PROFESSOR JAMES H. DIBLE, professor of pathology in the University of Liverpool, has been appointed to the chair of pathology in the British Postgraduate Medical School.

GEORGE J. BAKER, animal husbandman, has been appointed acting director of the extension service at the North Dakota Agricultural College at Fargo. He will supervise the activities of extension agents in forty-eight counties, and will be in direct charge of educational work which reaches into every community in the state.

DR. J. ROSSLYN EARP, of Santa Fe, formerly director of public health of New Mexico, has been made state medical editor to supervise the collection of and edit the technical material of the various publications issued by the State Health Department.

DR. F. MURGATROYD, of the Liverpool School of Tropical Medicine, who is at present engaged on research work on sleeping sickness in West Africa, has been appointed assistant physician to the London Hospital for Tropical Diseases.

A SIX-YEAR study of trachoma will be continued this autumn at Washington University School of Medicine on a broadened basis as the result of the renewal of a grant for the study by the Commonwealth Fund of New York. Dr. Louis A. Julianelle, who has been in charge of the work, will join the teaching faculty as associate professor of applied bacteriology and immunology.

DR. F. W. WARBURTON, associate professor of physics at the University of Kentucky, has been granted leave for the first term of the next academic year. He will undertake special research work on the electromagnetic theory at the Massachusetts Institute of Technology.

DR. G. H. HART, head of the Division of Animal Husbandry at the College of Agriculture of the University of California at Davis, has been invited to speak before the International Veterinary Conference, to be held in Zurich in 1938. The subject that has been assigned him is "Growth and Early Maturity." Other speakers on this subject are: Dr. Contescu, director of the National Zootechnical Institute, Bucharest, and Professor Letard, of the veterinary school at Alfort, France.

STANLEY P. YOUNG, who is chief of the Division of Game Management of the U. S. Biological Survey, is in charge of a scientific expedition for the survey, in which the Chicago Academy of Sciences, the Smithsonian Institution and the National Zoological Park are cooperating in the Carmen Mountain section of northeastern Coahuila, Mexico. The main objective of the expedition will be wildlife photography similar to that conducted in northeastern Louisiana three years ago. Other objectives will be the collection of specimens of mammals for the survey and the other scientific agencies concerned, and the live capture of mammals for the National Zoological Park in Washington, D. C. The expedition will return to the United States about October 10.

THE annual Metal Mining Convention and Exposition of the American Mining Congress will be held at Salt Lake City from September 7 to 10. Delegates will be welcomed to Utah at a luncheon session on September 7 by Governor Blood, of Utah, and Mayor E. B. Erwin, of Salt Lake City. Response to this welcome will be made by Howard I. Young, president of the American Mining Congress, Guy N. Bjorge, chairman of the National Program Committee, and William E. Goodman, chairman of the Manufacturers Division of the congress. W. J. O'Connor, manager of the American Smelting and Refining Company, Salt Lake City, will preside at the luncheon. W. Mont Ferry will act as toastmaster at the annual banquet on Thursday night, September 9.

A FOOD TECHNOLOGY CONFERENCE will be held from September 14 to 17, under the auspices of the Department of Biology and Public Health of the Massachusetts Institute of Technology. It is inaugurated for the benefit of those persons in scientific, technical or executive positions who wish to avail themselves of recent scientific information concerning food technology as it concerns certain of the food industries. The sessions of Tuesday, Wednesday and Thursday will be taken up with the reading of technical papers. On Friday the period from 9 to 11 A.M. will be devoted to round-table discussions, which will provide opportunity for members of the conference to enter discussion groups covering selected phases of the principal food technology operations. A trip to Gloucester, where an old-fashioned New England clambake will be provided by the courtesy of the Gorton-Pew Fish-

eries Company, Ltd., will follow. After the clambake, arrangements will be made for an inspection trip to the Gloucester fisheries and other representative food industries, including the Cherry Hill Farm of H. P. Hood and Sons.

THE International Meeting on Physics, Chemistry and Biology of the "Congrès du Palais de la Decouverte," under the presidency of M. Jean Perrin, will be held in Paris from September 30 to October 7, in connection with the International Exposition. The purpose of the meeting is to present the most recent advances in the domain of the sciences covered. Full information may be secured from L. W. Tomarkin, Institut de Chimie, 11 Rue Pierre Curie, Paris.

THE *Journal* of the American Medical Association states that the Casselberry Prize of $500 of the American Laryngological Association is now available as an award for research in laryngology and rhinology. Manuscripts should be sent to the secretary, Dr. James A. Babbitt, 1912 Spruce Street, Philadelphia, before February 1.

AN amendment to the third deficiency bill, allowing the Department of the Interior to acquire a 6,700-acre stand of sugar pine trees for addition to the Yosemite National Park in California, has been passed by the Congress. The sum of $2,005,000 is made available to the department, which may either acquire the area by purchase or condemnation under a previous authorization.

IT is stated in the *Journal* of the American Medical Association that the production of serums for pneumonia of types V, VII and VIII and any additional types that may be found to be of value in the future will be made possible by a fund of $400,000 appropriated by the recent legislature of New York state to the state department of health. About $150,000 will be used to enlarge the facilities of the division of laboratories to meet the increased load of serum production. In addition, the department will be able to develop further its typing facilities, to extend the program of graduate professional education through the Medical Society of the State of New York and of education for the general public and to do more extensive epidemiologic research when occasion offers. The pneumonia control program in its present form was begun on November 1, 1935, as a cooperative undertaking of the State Health Department, the State Medical Society, the State Association of Public Health Laboratories, the Metropolitan Life Insurance Company and the Commonwealth Fund, the last two giving financial assistance.

ACCORDING to the London *Times*, the world's second largest telescope, which has taken two years to make, will leave Newcastle, within the next few months, for the new Radcliffe Observatory, Pretoria. With a 35-foot duraluminium tube resembling the skeleton framework of a huge howitzer, this £40,000 telescope has been constructed at the optical works at Walkergate-on-Tyne of Sir Howard Grubb, Parsons and Co., Limited. The telescope, which is of the reflector type, has a "great" mirror 74 inches in diameter. The instrument will be housed in a steel turret, 61 feet in diameter, on a brick and cement building with a reinforced concrete floor. The turret will contain a new type of observation car, mounted on an arm which will travel all round the turret and be independent of the movement of the dome. The operator, from his car, will be able to control the movements of the entire structure. Although the moving parts alone weigh some 35 tons, the whole apparatus will be worked by push buttons. A high degree of accuracy in control is obtained by the use of a calibrated tuning fork kept in a constant temperature chamber; 18 motors will be used to operate the telescope. In addition to spectroscopic arrangements, high up on the side of the tube is a special camera. It has two guiding microscopes and can take exposures over a period of many hours.

TO obtain a clearer picture of the relation between rainfall and soil erosion, the Soil Conservation Service has established approximately five hundred weather observation stations in the watershed of the Muskingum River in Ohio, a region where precipitation is heavy. Working in cooperation with the Weather Bureau, the Ohio Works Progress Administration and the Muskingum Watershed Conservancy District, the service has set up the stations in an 8,000 square mile area extending over 22 counties. They are situated about four miles apart and are conducted by farmers from the relief rolls who have received training in reading weather recording instruments. Each station is supplied with a full set of weather instruments, including a minimum thermometer, wet and dry-bulb thermometers, anemometer, wind vane and self-recording rain gauge. The instruments are read every half hour from seven in the morning until seven at night. Each morning readings of the previous day are forwarded to headquarters at New Philadelphia, Ohio. There a cartographic staff records the movement and intensities of precipitation and other climatological information on detailed maps. Similar observations are being made in Kingfisher, Logan and Blaine Counties in Oklahoma and it is hoped to extend such observations into other areas.

IT is announced that a farm of a hundred acres, adjacent to the campus of Cornell University, has been purchased for an extension of the program of its physiological field station which for ten years has con-

ducted research in experimentally produced nervous disorders in animals under controlled conditions. The station, with its farm houses converted into laboratories and living quarters for the research staff and its barns modernized, will take care of a population of pedigreed pigs, sheep and other animals which will be built up to provide breeds of diverse temperaments. The behavior of the animals will be studied from birth to death in an attempt to clarify the understanding of the deviations from normal behavior which Pavlov designated as experimental neuroses. The work was started in 1921 by the late Professor Sutherland Simpson, whose special interest was the endocrine organs in health and disease. This work was advanced by employing Pavlov's methods for studying conditioned reflexes. Professor Liddell, a student of Dr. Simpson's, has carried on the work as head of the Physiological Field Station since that time, and with his staff has developed the techniques for studying these reflexes.

DISCUSSION

UPPER CRETACEOUS PLANTS FROM PATAGONIA

EXACTLY thirty years ago I published a brief note in this journal[1] which was inspired by an article by Kurtz,[2] in which he listed some twenty-five species of fossil plants that had been collected by Hauthal at a locality known as Cerro Guido in the Territory of Santa Cruz. Nearly all these plants were identified with well-known northern species that had been described by Heer, Lesquereux and Newberry from the Dakota sandstone of the western United States. Although Kurtz's paper lacked illustrations, it was presented with an air of finality that seemed to stamp it as an important contribution to Mid-Cretaceous plant geography.

I have always been curious about this Cerro Guido flora, especially since it has been my later lot to study a considerable number of collections of fossil plants from a variety of horizons in Patagonia, and since there has been a tendency among Argentine geologists to consider the Cerro Guido flora as probably Tertiary. With the exception of some very imperfect material collected by Simpson as leader of the Scarrett Patagonian Expeditions I have not seen any Upper Cretaceous plants from Patagonia until this last winter, in spite of the large amount of geological activity in this region, At that time I received a small but well-preserved collection from the Argentine Survey that had been made by the mining engineer, A. Paitnitzky.

This came from a locality known as Cerro Baguales on the north side of the valley of Rio Shehuen in Santa Cruz Territory and is from the same general region as the Cerro Guido flora of Kurtz. The name Baguales is the gaucho term for wild horses, and consequently it has been applied indiscriminately to very many places in the Argentine, but the location of the plant outcrop is rather definitely fixed by the river. The Rio Shehuen or Sehuen, often called the Rio Chalia, as by the writer in describing the Tertiary plants collected by the Bailey Willis survey, rises between Lago Viedma and Lago San Martin, and is the main southern tributary of the Rio Chico de Santa Cruz. Its valley is the type region of Ameghino's Sehuen stage or Sehuense.

There has been more unprofitable discussion of the stratigraphy and correlation of the Patagonian section by authors lacking first-hand information of the region than can be said of any other equal area of the earth's surface, largely because of the marvelous succession of vertebrate faunas. Ameghino, their nestor, had all the industry of a Cope and the genius of a Leidy, but his geological correlations with the northern hemisphere were not so happy and not only raised paleontological blood pressures and stimulated the secretion of vast quantities of printer's ink, but also tended to a lack of appreciation of his very great talents as a comparative anatomist.

The Cerro Baguales flora, as previously stated, is not large, and it has been possible to identify but ten species. These represent the genera Gleichenites, Dennstaedtia, Dryopterites, Protophyllocladus, Menispermites, Paranymphaea, Sterculia, Laurophyllum and Myrcia. With the exception of Sterculia and Myrcia, which are equally common from the Mid-Cretaceous to the present, this assemblage would be recognized instantly as of Upper Cretaceous age. All the species are new and, aside from the Cerro Guido plants recorded by Kurtz, there are no Upper Cretaceous plants with which comparisons can be made nearer than Texas, which, although it would not be strictly accurate to say was on the other side of the world, is distant about 90 degrees of latitude.

It has been possible to make fairly reliable comparisons with the Cerro Guido flora by studying the illustrations of the plants which Kurtz recorded as given in the works cited in his bibliography. The results are most interesting. A few will be mentioned, since it will be some time before my completed paper appears in print. The *Gleichenites* aff. *gracilis* Heer

[1] E. W. Berry, SCIENCE, 23: 509–510, 1906.
[2] F. Kurtz. Sobre la existencia de una Dakota-flora en la Patagonia Austro-occidental. Revista Museo de la Plata, tome 10, 18 pp., 1899.

of Kurtz is the new species of Gleichenites from Cerro Baguales; the *Asplenium dicksonianum* Heer of Kurtz is either the Dennstaedtia or the Dryopterites of the new collection, and probably represents both since Heer's species is polymorphic, and one of my genera is based upon fertile material, the sterile being much alike in the two genera; the *Cinnamomum heeri* Lesquereux of Kurtz is my new species of Menispermites; the *Protophyllum* cf. *rugosum* Lesquereux of Kurtz is my Paranymphaea; his *Sassafras acutilobum* Lesquereux, *Liquidambar integrifolium* Lesquereux, and probably some of the other of Lesquereux's species of Sassafras which he records, are the same as my new species of Sterculia from Cerro Baguales; Kurtz's *Salix proteaefolia* Lesq. is one of the two new species of Laurophyllum from Cerro Baguales, and probably includes also what Kurtz called *Quercus primordialis* Lesquereux; the second Laurophyllum from Cerro Baguales appears to be what Kurtz called *Perseophyllum hauthalianum*.

The foregoing seem conclusive, but do not dispose of all the names recorded by Kurtz. One or two comments seem pertinent to the remainder, although these must be regarded as tentative, since they are based upon opinion rather than factual evidence. I regard what Kurtz called *Liriodendron meeki* Lesquereux as a leguminous leaflet and not the same as what passes by this name in the northern hemisphere, which is also probably not related to Liriodendron. Kurtz's seed of Abietites is not related to the pines and probably belongs to some genus of the family Proteaceae. The Sequoia twig is probably of the same nature as the one recorded by Engelhardt from the Tertiary of Chile, *i.e.*, a Podocarpus.

If my conclusions are correct it means that the genera Sassafras, Liquidambar, Quercus, Protophyllum, Liriodendron, Abietites (Pinus ?), and Sequoia remain unknown on the South American continent, either from the Cretaceous or later down to the present. It means that there is no present basis for the concept of over a score of Dakota plants from the northern hemisphere reaching South America in a body and unchanged at near the beginning of the age of flowering plants in Mid-Cretaceous time.

It does not mean that there was not an avenue of land communication between North and South America at some time during the Upper Cretaceous. This is as clear as ever, and the Cerro Baguales flora is distinctly related to, and seems to have been derived from the northern hemisphere, as is also true of the Paleocene and Eocene floras of Patagonia.

As to the exact age of the Cerro Baguales flora it is, as aforesaid, definitely Upper Cretaceous. It seems quite as definitely to belong in the Patagonian stage known as the Salamanca. What precisely this is in the international Upper Cretaceous time-table is not so clear. Kurtz called his Cerro Guido plants Cenomanian, because the Dakota sandstone was then considered to be of that age, although I have long regarded it as Turonian. The most similar plants in the northern hemisphere to those from Cerro Baguales come from horizons usually referred to the Turonian, Emscherian and Aturian stages, but concerning which there are differences of opinion, especially as between the botanical and the zoological evidence, the paleobotanists usually considering the various horizons as about one sub-stage older than do the paleozoologists, although the latter authorities are not always in agreement. My tentative opinion is that this flora is late Emscherian or Aturian in age, and this would also include the Kurtz flora from Cerro Guido.

EDWARD W. BERRY
JOHNS HOPKINS UNIVERSITY

OBSERVATION ON EXCITATION OF FIREFLIES BY EXPLOSIONS

THE writer had an opportunity to observe an extraordinary phenomenon of excitability of fireflies by explosions on the Fourth of July, which is worthy of communication so that others who have a similar lucky opportunity may be prepared to make more exact observations or even experiment if located where loud noises can be made without objection.

While resting in his garden during the twilight of the evening of the Fourth to watch the fireflies, which this year have made there a much finer display than usual by their great numbers, the writer was startled by the sudden flashing up of the entire grass plot in front of him when some boys fired cannon crackers in the street in front of the house, about 80 feet away, while before only common firecrackers had been exploded half a long block down the street. In an area twenty by twenty feet directly before him, in which before and after only half a dozen fireflies at the most, usually less, could be observed, between forty and fifty were now counted.

The brilliancy of the spectacle was greatly enhanced by the more rapid flashing of the insects, which was at intervals of the ability to count one-two, while before and after it was at the rate of the count one-two-three-four—or a little slower—with now and then an excited individual flashing at the rate one-two.

A third striking feature was that all the fireflies kept in the grass or darted around just above it, altogether not more than one foot above the ground, and none whatever flew up to a height of ten or more feet, as a few always do under normal conditions.

When the infernal noise stopped after a short interval, probably not more than ten minutes, the entire grass plot, as the rest of the garden, fell into complete

darkness, all fireflies having ceased to flash except three that now rapidly rose into the cherry trees. After a time, which I failed to measure, the fireflies reappeared in their normal number, resuming their regular rate of flashing and their usual mode of flying in very irregular courses and at various heights.

The fireflies were determined by H. C. Fall through K. F. Chamberlain, assistant state entomologist, as belonging to the *Photinus scintillans-marginellus* group. As no "glow worms" were observed in the grass, it is probable that the females were of the luminous kind and flying. Only males were captured, however.

As Lutz in his "Field Book of Insects," points out, the lightning, in *Photinus* at least, is principally for sexual attraction. He adds: "Another view is that the light is a warning signal to nocturnal birds, bats, or other insectivorous animals. The family Lampyridae to which the lightning bugs belong is known to be refused by birds in general." It is therefore readily understood that the fireflies when frightened by the air vibrations, if not the noise of the firecrackers, raised their warning signals at double speed. This is especially obvious when it is remembered[1] that the flashing is the result of a stimulus conveyed by special nerves whereby oxygen is brought to the network of tracheae in the adipose tissue, thus producing a slow combustion, and being of the nature of a reflex motion.[2]

The sudden lighting up and nearly as abrupt darkening of the garden could be considered as rude major synchronous flashing induced by vibrations of the air. This is somewhat in line with the observations of Hess,[3] who found that he could initiate synchronous flashing by means of a pocket flashlight and even cause the insects to adopt a somewhat higher frequency of flashing. Also in this case the more rapid flashing was of the nature of a warning signal, and it is worth noting that the fireflies excited by the cannon crackers showed a double frequency of flashing. Flashing, therefore, on occasion serves undoubtedly as a warning signal besides its usual sexual function.

A perusal of literature indicates that various theories have been advanced to explain the concerted action or photosynchrony. Most recent authors[4] believe that the synchronous flashing is led by a pacemaker. This theory of "sympathy" is supported by observations like those of Alexander who saw the flashes passing like waves over a long row of trees near Bangkok and noted slight differences in time of flashing but not in frequency. Others have tried to explain the synchronous flashing by the influence of concerted movement. Thus von Osten-Sacken (see Brehm's Tierleben) observed the synchronous flashing of the American species *Photinus pyralis* L. to be connected with rhythmic up-and-down movements of the swarms of fireflies, and Allard[5] notes that as the creatures arise very slowly, each flash is attended by a sudden upward flight-impulse which may even carry them almost straight up several feet. On the other hand, the frightened and more rapidly flashing fireflies which the writer saw in his garden kept strictly near the ground and Morrison observed the synchronism near Bangkok on still as well as on quite windy days. It seems, therefore, that the photosynchrony is somewhat dependent on the movements of the beetles, but independent from the stimulating influence of breezes, as one might suspect. The major influence in the synchronism is then apparently the reflex action of the fireflies on seeing the light of the luminous pacemaker. This mass action may, however, have been originally induced by a strong external stimulus, such as the air vibrations proceeding from the cannon crackers, and the writer had, indeed, the impression that there followed upon the general luminosity of the fireflies a period of longer intervals of more general flashing and of prevailing darkness.

RUDOLF RUEDEMANN

NEW YORK STATE MUSEUM,
ALBANY

[1] See Vernon L. Kellogg, "American Insects," p. 269, 1908.

[2] The sudden luminosity of the fireflies upon being frightened reminds the writer of a similar effect he saw on a night when the Atlantic Ocean was brilliantly phosphorescent and the bathtub filled with sea water would become a fiery phosphorescent mass every time the water was agitated. Also in this case, the *Noctilucas*, even though lowly protozoans, responded by suddenly flashing up upon being disturbed, in this case the layer of protoplasm below the cuticle being active.

[3] W. N. Hess, *Biological Bulletin*, 38: 39–77, 1920.

[4] As, for instance, T. F. Morrison, SCIENCE, 69: 400–401, 1920, and G. Alexander, SCIENCE, 82: 400, 1935.

SECONDARY BINOCULAR VISION IN BIRDS

IT has been pointed out by Dunlap and Mowrer that "due to the relatively restricted magnitude of possible eye movement in most avian species, the field of vision is usually changed by means of quick jerky movements of the entire head instead of by means of the so-called 'saccadic' eye movements so conspicuous, for example, in human beings and other Primates." They called attention to the possibility of the nictitating membrane, or "third eyelid," having a function in birds somewhat comparable to that of a shutter in a motion picture camera.

The head movements of birds, in so far as they are concerned with vision, are of three types: (1) Movements that effect a change in the visual field; (2) movements tending to maintain a given visual field during bodily displacement; and (3) movements tending to hold the image of a moving object motionless on the retina.

[5] H. A. Allard, SCIENCE, 52: 539, 1920.

Movements for the purpose of changing the visual field are of three main types, horizontal, vertical and "peering." For the sake of simplicity I shall confine myself to the first two.

Horizontal movements, well illustrated by doves, pigeons and fowl when walking, and by coot and gallinules while swimming on a still pond, consist of an apparent movement of the head backward and forward. It was suggested by Mikesh and demonstrated by Dunlap and Mowrer that the only real motion is forward; that although the head appears to be drawn back after each forward thrust it is really maintained in the same relation to the visual field, while the body moves forward. There is therefore an alternation of short maintenance of and sudden change in the visual field.

Vertical head movement is seen in many shore birds, which, while standing still, bob their heads up and down with a greater or lesser pause at the uppermost and lowermost positions.

Undoubtedly a number of different causative factors enter into this head movement on the part of birds—indeed, several have been suggested. But whatever the causative factors may be there is one resultant of the head movement of much importance that appears to have been overlooked.

The vision of most birds is monocular, the visual fields of the two eyes being quite independent of each other. Monocular vision with two eyes, each having a short focus wide angle lens, has the advantage of giving a sharp and distinct retinal image of everything within two large visual fields. But it has the disadvantage of recording two independent single images each in a single focal plane, resulting in more or less inability to judge accurately the distance of any given object from the fixed point of the single eye bearing upon the object.

This disadvantage is overcome by the horizontal head movements of such birds as the doves, pigeons, coots and gallinules and by the vertical head movements of the shore birds. Such head movements provide a base line from which distances may be measured, and the blotting out of the image between the extremes of this base line, assuming a retinal lag, results in a stereoscopic effect.

Thus the birds, under the apparent physical handicap of monocular vision, in reality, as a resultant of the movements of the head, possess all the advantages of binocular vision, in addition to the advantages inherent in double monocular vision.

Although it is believed that the attainment of the advantages of binocular vision is an important factor in the head movements of birds, it is not assumed that it is the only factor, or that it explains its origin.

AUSTIN H. CLARK

U. S. NATIONAL MUSEUM

AN INFECTIOUS DISEASE CAUSING WIDESPREAD NECROSIS IN THE LIVER OF THE MEXICAN AXOLOTL

AN inbred colony varying from 400 to 800 white and black axolotls (*Amblystoma mexicanum*), raised from four pairs of breeders brought from Europe, has been maintained at the Morris Biological Farm of the Wistar Institute since 1931. About a year ago a disease appeared which has since spread through the entire colony and has destroyed most of the animals.

The disease develops so insidiously that it is usually not recognized until well advanced. Commonly, though not in all cases, the earlier external signs are similar to those of approaching metamorphosis and consist in partial reduction of the gills and the tail-fin and in wasting of the arms and legs, which gradually lose their well-rounded, fleshy appearance. The white axolotls often become faintly flushed because of congestion of cutaneous capillaries; occasionally blood blisters form in the fin. In the black variety these vascular phenomena are masked by the cutaneous pigment cells.

The axolotls lose their appetite and finally refuse food altogether. However, the resulting emaciation may not be obvious, because in many animals considerable quantities of fluid accumulate in the coelomic cavity, leading to a bloated appearance. This, indeed, is the most striking sign of the disease, though it is not always present. If withdrawn with an aspirating needle, fluid reaccumulates within a few days. It is slightly turbid and contains many wandering cells and fine granules from broken-down chromatophores. Micro-organisms have not been demonstrated by various aerobic and anaerobic culture methods, nor by direct smears, though the granules mentioned may readily be mistaken for bacteria.

At autopsy the most conspicuous lesions are found in the liver, which is usually enlarged, often to over twice its normal size, and coated with a film of fibrinous exudate. Frequently the surface is very irregular, due to the presence of projecting coarse nodules, which are white, solitary or multiple, and vary from a few millimeters to over a centimeter in diameter; they contrast sharply with the more normal gray liver (especially in the black variety). The nodules vary much in consistency, depending on the stage of the disease; some are quite firm, while others are soft, with obviously necrotic centers. Usually they are well circumscribed and surrounded by a zone of congestion. Histologically the nodules are found to consist of necrotic liver cells, which in the ventral parts have fused into a structureless mass; at the periphery the area is usually invaded by wandering cells, which, together with fibroblasts, may form a zone of considerable extent. The liver cells beyond these localized lesions exhibit various stages of degeneration.

While the hepatic lesions dominate the picture, less conspicuous degenerative changes are present in other organs, particularly the gonads and the spleen. Transmission experiments conducted with axolotls brought from other laboratories indicate that the disease is infectious.

The authors would appreciate hearing from any one who has encountered similar disease in axolotls or related cold-blooded forms.

CRANFORD HUTCHINSON
THE WISTAR INSTITUTE
BALDUIN LUCKÉ
UNIVERSITY OF PENNSYLVANIA

SPECIAL ARTICLES

SOME OXIDATIVE PROPERTIES OF ISOLATED AMPHIBIAN GERMINAL VESICLES

THE classical opinion which considers the nucleus as a center of respiratory metabolism has been recently questioned by several investigators. The rH measurements of Rapkine and Wurmser[1] and of Chambers[2] and his collaborators failed to indicate any considerable oxidizing or reducing ability in the nucleus; likewise, experiments in which the metabolic rate of non-nucleated and nucleated fragments of Arbacia eggs (obtained by ultracentrifugation) was compared show no particular respiratory activity in the nucleus (Shapiro,[3] Navez and E. B. Harvey[4]).

In view of these divergent opinions, it was of interest to study the respiration of isolated amphibian germinal vesicles; the removal of the nucleus in full-grown oocytes is a rather easy task (Duryee[5]) and a sufficient amount of material can be obtained in a short time.

Some preliminary tests carried out on *Rana fusca* isolated germinal vesicles indicated that the nuclear sap and the nucleoli are able to reduce methylene blue; leuco-methylene blue is specially oxidized by the nucleoli. On the other hand, chemical tests for indophenoloxidase, peroxidase and glutathione were entirely negative.

In order to get quantitative data, the CO_2 elimination of *Rana fusca* germinal vesicles was measured by a microtitrimetric method and the oxygen consumption of Triturus pyrrhogaster isolated nuclei was followed in a modified Gerard-Hartline microrespirometer, kindly placed at my disposal by Dr. Herbert Shapiro. The metabolism of full-grown oocytes deprived of their follicular epithelium was estimated at the same time. The Qo_2 (mm^3 O_2 per gr wet weight per hour) of the isolated nuclei was found to be about 13, while the Qo_2 of the oocyte is around 37. In both cases, the metabolism remained constant during several hours. If the respiration of one single nucleus is compared to the metabolism of one oocyte, it is found, both for oxygen consumption and for carbon dioxide elimination, that the gas exchange of the nucleus represents from 1 to 1.5 per cent. of the metabolism of the whole intact cell. It is often possible in *Rana fusca* to remove the nucleus from the oocyte without much loss of cytoplasm; if this enucleated egg-cell is allowed to heal and CO_2 elimination is measured, it is found that the loss of the nucleus does not induce any considerable drop of the metabolism during many hours.

In order to check the possibility that the low respiration of the isolated nuclei might result from an insufficient amount of oxidizable substrate, either glucose or cytoplasm removed from an oocyte by means of a micropipette was added to the germinal vesicles; no definite increase in the metabolic rate could be detected in such conditions.

The influence of calcium on the physical properties of the chromosomes in isolated germinal vesicles has been demonstrated by Duryee; but the presence or absence of Ca ions did not affect significantly the oxygen consumption or the carbon dioxide elimination in these experiments.

These observations indicate that the nucleus is probably not a center of high metabolism in the growing oocyte, although the importance of the germinal vesicle in other respects must not be overlooked.

JEAN BRACHET
DEPARTMENT OF BIOLOGY
PRINCETON UNIVERSITY, AND THE
EMBRYOLOGICAL LABORATORY
MEDICAL SCHOOL
UNIVERSITY OF BRUSSELS

[1] L. Rapkine and R. Wurmser, *C.R. Soc. Biol.*, 94: 1347–1349, 1926.
[2] R. Chambers, H. Pollack and B. Cohen, *Jour. Exp. Biol.*, 6: 229, 1929.
[3] H. Shapiro, *Jour. Cell. Comp. Physiol.*, 6: 101–116, 1935.
[4] A. Navez and E. B. Harvey, *Biol. Bull.*, 69: 342, 1935.
[5] W. R. Duryee, *Arch. Exp. Zellf.*, 19: 171–176, 1937.

COBALT AS AN ESSENTIAL ELEMENT IN ANIMAL NUTRITION

NATURAL conditions have been encountered in west Australia, New Zealand and Florida (the latter probably extending over the coastal plains of the Gulf and Atlantic coasts) in which cobalt must be supplied for the well-being of sheep and cattle. General observations indicate that the effects of the deficiency may affect other animals and even people on a "live-at-home" diet.

Filmer and Underwood[1] reported in 1934 the preparation of an iron-free filtrate from a limonite effective

[1] J. F. Filmer and E. J. Underwood, *Australian Vet. Jour.*, 10: 83–92, 1934.

in preventing enzootic marasmus in sheep. Fractionation of this filtrate and tests of the elements in the effective fraction resulted in Underwood and Filmer[2] announcing in 1935 that cobalt was the potent element in effective limonite. This was the first evidence that cobalt was an essential element.

At that time, Grimmett and Shorland[3] held that iron *per se* was necessary for the prevention of "bush sickness" in New Zealand, but that cobalt and other elements might have a stimulating effect. Denham[4] has reviewed the present status of the investigation of cobalt deficiency in New Zealand. Ferric ammonium citrate and iron ores effective in preventing bush sickness or "skinnies" owed their efficacy to their cobalt content. Other ores that were ineffective did not have equivalent cobalt contents. Cobalt alone has been effective in the more recent experiments.

In Florida, on certain soil types, ferric ammonium citrate or a commercial red oxide of iron and copper sulfate have been effective in overcoming a nutritional anemia in cattle known as "salt sick." On other soils, this treatment has been ineffective in inducing and maintaining normal function due to an overlapping of cobalt deficiency. In controlled feeding experiments with calves on a ration of Natal grass (*Tricholena rosea*) hay, shelled corn and dried skim milk, a malnutrition has been produced that is corrected by cobalt supplement, and apparently is aggravated by the use of ferric ammonium citrate and copper sulfate. None of these feeds showed cobalt to be present upon spectrographic examination.

Affected animals show a long rough hair coat, scaliness of the skin, listlessness, retarded development of sexual characteristics, gauntness due to loss of appetite and muscular atrophy. The erythrocyte count may be above average, and the hemoglobin concentration equal to or above that in animals receiving cobalt and making normal growth. Volume and color indices show that the condition is a microcytic hypochromic anemia. The spleen is shriveled and fibrous and the heart of normal size but usually flabby.

Examples of growth rates of Jersey calves are shown in Fig. 1. Animal No. E-79, receiving 5 mgs cobalt per day, made uniform gains until he weighed over 550 pounds. Irregularities in his growth curve and that of E-74 at the higher weights may be attributed to a marginal cobalt intake or to an additional undetermined deficiency. That cobalt intake may have been marginal is shown by the increased growth of E-86 when the cobalt intake was increased. Animal No. E-86, receiving cobalt, weighed 85 pounds more than E-85 on the basal ration at 14 months of age, and

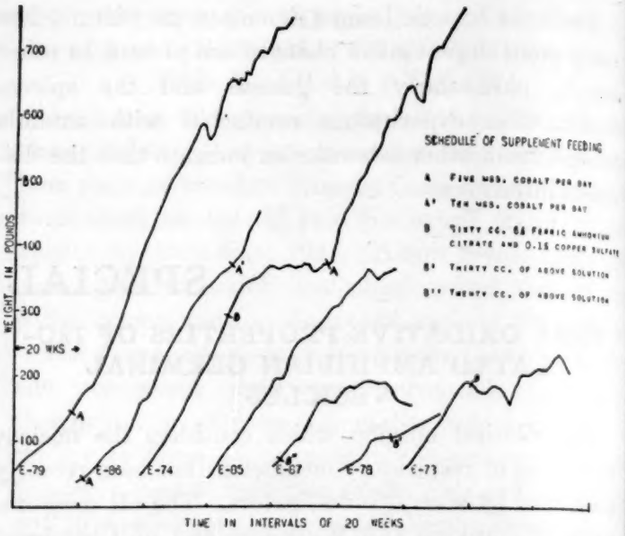

FIG. 1. Growth curves of calves showing the effect of cobalt, and iron and copper supplements, with a ration of Natal grass hay, shelled corn and dried skim milk, the hay and corn being produced on deficient land.

the differences in physical appearance were even more striking. The retarded growth due to the use of ferric ammonium citrate and copper sulfate is shown in the curves for E-74, E-87, E-78 and E-73. No calf has been raised to a weight of over 450 pounds on this ration of Natal grass hay, shelled corn and dried skim milk without the use of a cobalt supplement.

Animal No. E-79, when slaughtered, appeared to be normal, including microscopic examination of the heart, liver and spleen, the organs most affected.

The indispensability of any element in nutrition can be determined only under conditions in which the addition of the element in question is required for a continuance of normal physiological function. These conditions may be encountered naturally or they may be produced artificially. The requirement of animals for certain minerals is so minimal in quantity, and their determination so difficult, that such minerals have not been considered as essential because rations have not been prepared sufficiently free of them to cause a failure of normal functions. Cobalt has been one of these elements.

W. M. NEAL
C. F. AHMANN

FLORIDA AGRICULTURAL EXPERIMENT STATION

MAGNESIUM SULFATE—AN UNSATISFACTORY SUBSTITUTE FOR ARSENICALS IN GRASSHOPPER BAITS

WIDE publicity was given to a short note by Hubert W. Frings and Mable S. Frings which was published in SCIENCE[1] in which a formula with from 20 to 25 per cent. magnesium sulfate (Epsom salts) was recommended as being as effective as 5 per cent. arsenic in grasshopper bait. The communication was printed

[2] E. J. Underwood and J. F. Filmer, *Australian Vet. Jour.*, 11: 89–92, 1935.

[3] R. E. R. Grimmett and F. B. Shorland, *New Zealand Jour. Agr.*, 50: 367, 1935.

[4] H. G. Denham, SCIENCE, 85: 382–383, 1937.

[1] 85: 2209, 428, April 30, 1937.

under "Discussion" and the authors stated that "since there were neither time nor facilities to make complete tests, the results are only preliminary."

The substance of this article was published by Science Service and was widely copied by newspapers. As a result, many farmers throughout the central west used Epsom salts in grasshopper baits, but in every case so far reported unsatisfactory results were obtained. The publicity brought a heavy correspondence, and insecticide dealers featured magnesium sulfate in their lists, giving special quotations on ton lots.

Three small and one large field tests of Epsom salts bait in comparison with bait made with standard poisons have just been completed by the writer with the uniform results that Epsom salts did not give satisfactory results. Since this matter is of wide public interest, a brief account of these tests has been prepared for publication.

EPSOM SALTS GRASSHOPPER BAIT TESTS

The Epsom salts bait was tested in so-called single and double strength mixtures in infested alfalfa fields and gardens in comparison with the regular mixtures made with sodium arsenite. The exact mixtures used were as follows:

(1) EPSOM SALTS BAIT

(a) Frings' formula:

Bran	60 to 65 per cent.
Molasses	15 per cent.
Epsom salts	20 to 25 per cent.
Water to moisten	

(b) As used in tests, single strength:

Bran 3 lbs., sawdust 3 lbs. =	6 lbs.
Molasses, black strap, 1 pt. =	1½ "
Epsom salts	2 "
Water	1 gal.

(2) DOUBLE STRENGTH EPSOM SALTS

Bran 2½ lbs., sawdust 2½ lbs. =	5 lbs.
Epsom salts	4 "
Molasses	1 lb.
Amyl acetate	½ oz.
Water to moisten, about	3 qts.

(3) SODIUM ARSENITE BAIT

(a) 1 quart of Pierson-Ferguson "hopper poison" (being a mixture of sodium arsenite, amyl acetate and molasses) to 3 lbs. of bran, 3 lbs. of sawdust and 1 gal. of water.

(b) 1 pint of sodium arsenite (4 lbs. material), 1 qt. black strap molasses, 3 oz. amyl acetate (banana oil), 10 lbs. of bran, 10 lbs. of sawdust and 3 gals. of water.

These baits were mixed in clean tubs the evening before sowing. The Epsom salts were purchased at a local drug store at the rate of twenty-nine cents for five pounds. The bait was sowed thinly or at the rate of about seven to ten pounds to the acre at about 6 o'clock in the morning. Two hours after sowing, between fifty and one hundred grasshoppers, about three fourths of which were nymphs, were swept from the area where the bait was sown and they were confined in large screen cages over alfalfa plants to await counts of the live and dead hoppers at twenty-four and forty-eight hours. Another set of sweepings was made four to six hours after sowing and caged in the same way. This constitutes the most widely accepted manner of testing grasshopper baits. As a check, sweepings were made for a similar collection of hoppers at the two- and four-hour intervals where bait was not sown. These were caged in the same way and the proportionate number of hoppers dying naturally or from injuries was subtracted from the number found dead in the poisoned lots in figuring the per cent. kill. The counts with the per cent. kill are given in Table 1.

TABLE 1

RESULTS OF TESTS WITH GRASSHOPPER BAITS MADE WITH EPSOM SALTS (SINGLE AND DOUBLE STRENGTH) IN COMPARISON WITH STANDARD BAITS

Date	Formula used	Place sown	Cage counts at end of 48 hours from collections of hoppers collected				Net per cent. kill	
			Two hours after sowing		Four to six hours after sowing		Two hour coll.	Four to six hour coll.
			live	dead	live	dead		
June 21, 1937	Epsom salts (1b)	Border of alfalfa field	74	4	86	5	0	0
June 21, 1937	Sodium arsenite (3a)	Same	46	61	31	11	54	20.5
June 21, 1937	Check cage	Another alfalfa field	70	5	70	5	...	...
June 27, 1937	Epsom salts dble. strength (2)	Alfalfa field	49	6	116	9	0	0
June 27, 1937	Sodium arsenite (3a)	" "	60	15	61	9	10.4	3.1
June 27, 1937	Check	" "	71	9	45	5	...	...
June 30, 1937	Epsom salts (2)	" "	50	2	75	5	0	0
June 30, 1937	Sodium arsenite (3a)	" "	75	6	25	110	2.6	80
June 30, 1937	Check	" "	75	4	140	11	...	...
July 14, 1937	20% Epsom salts 5% $CaCl_2$	Atchison corn field	42	2	68	10	0	4.2
July 14, 1937	Paris green, standard bait	" " "	24	6	22	34	11.1	56.9
July 14, 1937	Check	" " "	21	2	...	...	...	...

Hungry grasshoppers were exposed to small quantities of these baits in small cages against a check made omitting the poison, and they fed on all of them. This would indicate that both the single and double strength Epsom salts baits were acceptable to grasshoppers. They died in the Epsom salts cages somewhat faster than in the check cages of unpoisoned bran mash, but that is regarded as of little significance.

Observations on the caged hoppers from the experimental plots after the forty-eight-hour period when the last counts were made showed that there was no larger death loss in the Epsom salts cages than in the check cages. In other words, Epsom salts did not kill the hoppers after forty-eight hours.

Cabbage, sweet corn, tomatoes, string beans and squash foliage were sprayed with a nearly saturated solution of Epsom salts (2⅛ oz. in 4 oz. or 100 cc of water at 70° F.) and no injury was done to the plants. Cabbage loopers and cabbage worms on the cabbage were not killed by the spray.

The three series of sowings indicate that Epsom salts used in bran mixture grasshopper bait was uniformly unsuccessful. Even double the recommended amount of Epsom salts in bait mixtures was ineffective. In these tests, Epsom salts was without value for destroying grasshoppers.

A field test of Epsom salts plus calcium chloride against the standard Paris green bait was made in a heavily infested field of corn near Atchison, Kansas, on July 14 in company with Dr. Harry Miller, of The Chemical Foundation of Kansas. A sowing of 120 pounds of bait according to Dr. Miller's modification of the Frings' formula of 20 per cent. magnesium sulfate (Dow Chemical Company) and 5 per cent. crude calcium chloride against one hundred pounds of Paris green bait gave a net kill of 4.2 per cent. at forty-eight hours against 56.9 per cent. for Paris green.

A survey of the literature offers little evidence that magnesium sulfate has any value as an insecticide whatsoever. There is not a single really impressive field control demonstration recorded. The small test by Hawkins against the wheat wire worm mentioned by the Frings' was apparently not regarded as significant by him, for he drew no practical conclusions from it.

The action of magnesium sulfate on the lower animals is primarily anesthetic. There was no cathartic action observed on the grasshoppers.

It is unfortunate that the extensive publicity on the supposed value of Epsom salts resulted in widespread use of a material that appears to be ineffective for the purpose. It is serious, because many persons may have their faith in the standard bait method weakened. At the present time, only sodium arsenite, white arsenic, gray or crude arsenic, Paris green, sodium fluoride and sodium fluosilicate in baits give anything approaching satisfactory control of hoppers. For the present at least, Epsom salts can not be recommended as a satisfactory control for any insect.

ROGER C. SMITH
KANSAS AGRICULTURAL EXPERIMENT STATION,
MANHATTAN, KANSAS

FITNESS, SULFANILAMIDE AND PNEUMOCOCCUS INFECTION IN THE RABBIT

THIS is a preliminary report of an investigation of the extent to which the effectiveness of sulfanilamide in experimental pneumococcus infection, in the rabbit, may be determined by factors reflected in the fitness rating.

The fitness rating is an index of condition and of capacity for resistance. Rabbits with high fitness ratings accomplish the removal of intravenously injected pneumococci from the blood more rapidly than rabbits with ratings appreciably lower.[1]

Transient improvement in fitness rating has been obtained in 70 per cent. of sixty-three rabbits given extract of adrenal cortex, extract of liver, vitamin B_1 or vitamin C. Intravenous injection of the latter substance, ten minutes before intravenous infection with type I pneumococcus, has been followed by substantial increase in capacity for the removal of pneumococci from the blood. Seven out of eleven rabbits, so treated, were enabled to reach a negative blood culture in one-half hour, as compared with a proportion of three out of twelve in a series of comparable controls.

The percentage recovery in a series of forty-four rabbits infected intradermally with a virulent strain of type I pneumococcus was as follows: 33 per cent. for six untreated, control rabbits with fitness ratings above the critical level of 0.6; 86 per cent. for seven rabbits of equivalent rating, given sulfanilamide at the beginning of the second and sixth hours of infection and at six-hour intervals thereafter; 100 per cent. in five equivalent rabbits given vitamin C in addition to sulfanilamide at the times stated; 0 per cent. for seven untreated, control rabbits with fitness ratings between 0.6 and 0.4; 25 per cent. for eight rabbits comparably low-grade but given sulfanilamide; 71 per cent. for seven similar rabbits given sulfanilamide plus vitamin C; 100 per cent. for four, only, equivalent rabbits given sulfanilamide plus either liver extract or vitamin B_1.

The contribution of the sulfanilamide was apparent in the increase in percentage survival in the higher

[1] A. Locke, *Jour. Infect. Dis.*, 60: 106, 1937.

fitness groups from 33 per cent., in the absence of treatment, to 86 per cent., when given sulfanilamide. The contribution of the adjunctive supporting treatment was apparent in the increase in percentage survival in the lower fitness groups from 25 per cent., with sulfanilamide alone, to 71–100 per cent. with sulfanilamide plus vitamin C, vitamin B_1 or liver extract.

The rabbits which survived were, almost altogether, those able to hold a negative blood culture, in spite of lesions at site of injection, as large, at twenty-four hours, as were observed in the controls. The percentage coming through to recovery without persisting fever or substantial weight loss was, for the higher fitness group receiving no treatment, sulfanilamide alone, and sulfanilamide plus adjuvant, respectively: 0, 57 and 60; for the corresponding lower fitness groups: 0, 25 and 64.

Treatment with sulfanilamide and especially with sulfanilamide plus fitness-promoting adjuvant tends to keep the blood stream clear enough of pneumococci invading from infected foci, in the rabbit, to permit the natural defensive forces to get an upper hand.

Detailed report will be deferred until completion of studies under way on optimum dosage and timing, limitations imposed by fitness-impairing potentialities of sulfanilamide itself; and considerations necessary because of differences in rate of conjugation of sulfanilamide to a less active derivative, in rabbits of divergent fitness rating.

ARTHUR LOCKE
R. B. LOCKE
R. J. BRAGDON
R. R. MELLON

THE WESTERN PENNSYLVANIA HOSPITAL
PITTSBURGH

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN ELECTRIC CARDIOMETER

THE recording of the heart beat by the commonly used pneumatic method is not fully satisfactory because the adjustment of the apparatus is critical, and comparatively slight bodily movements on the part of the subject are sufficient to interfere with the registering. This latter defect becomes particularly serious during studies in the physiology of exercise, and in psychological experiments involving the determination of the cardiac rate immediately following strong stimuli, when movement is apt to occur.

Boas[1] seems to have been the first investigator to employ the action potential of the heart for recording purposes during exercise. He made use of a battery-operated vacuum tube amplifier controlling a sensitive relay, which actuated a second relay carrying contacts for operating an electric counter and pen recorder. This apparatus was found to operate perfectly when the various contacts, relays and amplification controls were properly adjusted, provided that the subject remained well insulated from the ground, did not touch other persons and did not engage in certain types of generalized muscular activity. Benedict, Lee and Striech[2] used the Boas apparatus successfully in connection with the bicycle ergometer.

Recent improvements in vacuum tube design have made it possible to develop a similar apparatus which operates from the 60-cycle lighting circuit, is rugged and non-critical in adjustment and apparently is free from the defects of the Boas instrument. The new apparatus is $9 \times 11 \times 17$ inches in size, weighs approximately 30 pounds when mounted in a steel cabinet and is self-contained.

The electrode system is similar to the one used by Boas, with the exception that the indifferent contact consists of a wire placed in the mouth instead of a cup electrode on the right side of the chest. It is bent in such a manner that it is self-retaining and does not interfere with breathing. This contact is connected to the grounded shield of a rubber-covered microphone cable, and the active electrode is connected through the center wire of this cable to the amplifier shown in the figure. The active electrode, which may be a metal plate covered with moistened cotton or kaolin paste, is placed over the apex of the heart.

The amplifier is of the four-stage resistance-coupled type, designed by the writer for studying nerve action potentials. Its over-all voltage gain is well over one million, with a noise level of about four microvolts. A double pole switch (S) is provided for inserting a band-pass filter into the input and output of one of the stages. Experimentally, the filter seems most effective for cardiometric work when both sections are resonated at 20 cycles. This may be accomplished by using 500 H. inductors shunted with 0.1 Mfd. capacitors. The output of the amplifier actuates a small copper oxide milliammeter having a light weight pointer, and also excites the grid of a gas-triode tube. When the grid of this tube becomes relatively positive (this occurs at each heart beat) anode current continuously flows through the coil of the electric counter until the anode potential is reduced below the ionization point. The amplified cardiac potential, therefore, simply acts as a trigger to start the anode current in this tube. Once started, the current flow maintains

[1] E. P. Boas, *Arch. Int. Med.*, 41: 403, 1928.
[2] F. G. Benedict, R. C. Lee and F. Striech, *Arbeitsphysiologie*, 8: 266, 1934.

itself. When the counter has completed its stroke a short-circuiting contact is made which momentarily reduces the anode potential to a value low enough to stop the current flow, whereupon the contact opens as the counter armature returns and awaits the next heart beat. It will be noted that this contact operates *after* the stroke has been completed, and therefore imperfections in the contact cause no inaccuracy in the count, provided only that the potential is reduced for an instant below the ionization value before the next beat.

A telephone message counter in which the original armature has been replaced with one made from 1/32 inch steel has been found to work perfectly as a counter up to 235 strokes per minute (this high rate was secured by artificial means). It is not necessary to use other contacts if a graphic record of the beat is desired, as a thread connected to a recording pen can be attached to a flat spring which is placed so that it is hit by the counter armature near the end of its stroke. The counter and other parts of the output circuit must be well shielded, as must the circuits associated with the first amplifier stage. Also, the first 6F5 tube must be carefully selected, as about 30 per cent. of the tubes commercially available seem to have a very high hum level or are defective in other ways.

This apparatus seems to be very dependable in operation. It is only necessary to attach the electrodes, turn the amplifier on and adjust the amplification so that the meter needle swings well above the point at which the trigger action occurs. The setting is not at all critical. If the amplification is more than about 15 fold above this value, multiple counts may occur due to electric feed-back between the counter and amplifier, but, in practical use, such high amplification is not necessary. When the electrodes are properly placed, the uninsulated subject can engage in any sort of violent activity without affecting the count.

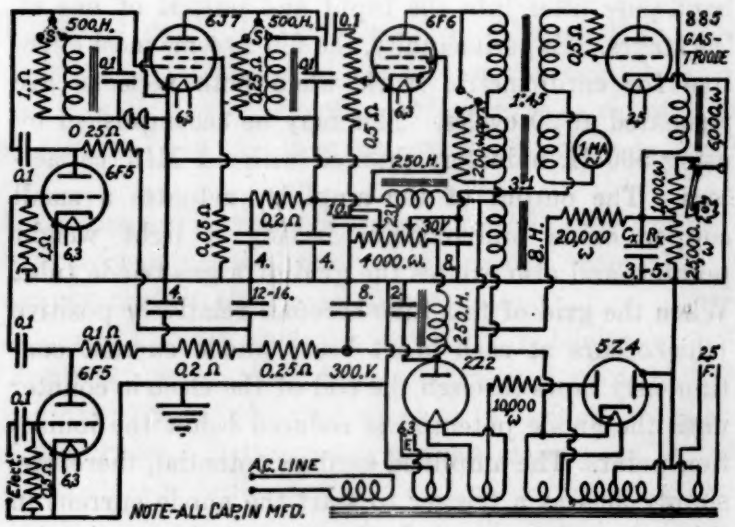

FIG. 1. The electric cardiometer.

The device seems particularly well adapted to the graphic recording of rate in connection with magnetic-clutch operated interval recorders as described by Fleisch[3] and by Gesell.[4] Additional contacts are not necessary; the magnet coil of the Fleisch apparatus, for example, is simply placed in series with the resistance R_x (see Fig. 1), which is reduced to compensate for the resistance of the coil. Experiments in progress indicate that a differentially wound magnet coil for the clutch is even better, as the anode current of the gas-triode can then release the clutch while at the same time the counter is being actuated. The clutch is "off" for the duration of the counter stroke which seems to be reasonably constant and which may be varied within limits by changing capacitor C_x and associated resistors.

FRANKLIN HENRY

UNIVERSITY OF CALIFORNIA
BERKELEY

[3] A. Fleisch, *Am. Jour. Psychol.*, 45: 335, 1933.
[4] R. Gesell, SCIENCE, 79: 275, 1934.

BOOKS RECEIVED

BAUGHMAN, IMO P. *Elementary Chemistry.* Second edition, revised. Pp. 296. 19 figures. Lea and Febiger. $2.75.

BAWDEN, ARTHUR T. *Man's Physical Universe.* Pp. xvii + 812. 368 figures. Macmillan. $3.50.

COLLINS, KREIGH. *Tricks, Toys and Tim; A Book of Model-making and Magic.* Pp. xii + 238. Illustrated. Appleton-Century. $2.00.

CRAMER, HARALD. Cambridge Tracts in Mathematics and Mathematical Physics. *No. 36—Random Variables and Probability Distributions.* Pp. 120. Cambridge University Press, Macmillan. $2.25.

DARWIN, CHARLES. *The Origin of Species.* (Condensed). Pp. 112. Quarter Books, Los Angeles. $0.25.

ENGLISH, O. SPURGEON and GERALD H. J. PEARSON. *Common Neuroses of Children and Adults.* Pp. 320. $3.50.

KOLTHOFF, I. M. *Acid-base Indicators.* Translated by CHARLES ROSENBLUM. Pp. ix + 414. Macmillan. $7.00.

LANDÉ, ALFRED. *Principles of Quantum Mechanics.* Pp. vii + 115. 15 figures. Macmillan. $2.25.

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